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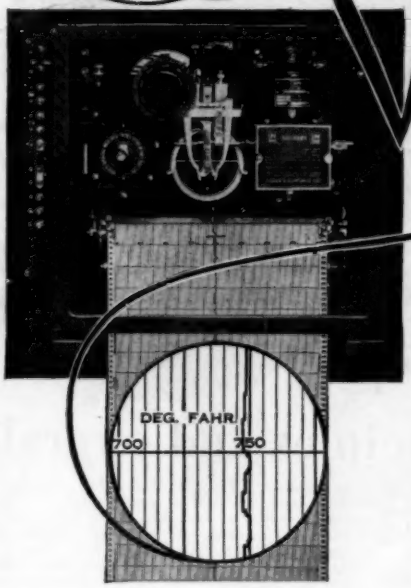

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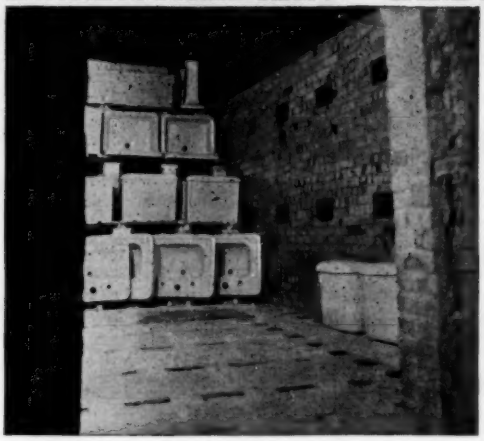

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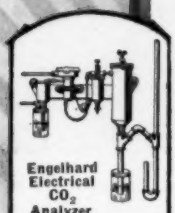

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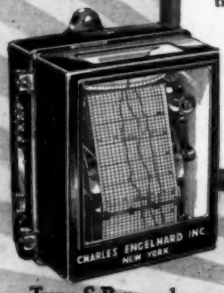

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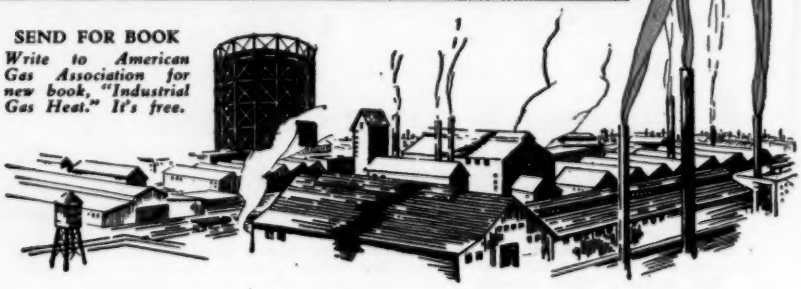

AMERICAN CERAMIC SOCIETY

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BERYLLIUM GLASS[1]

By Chi Fang Lai[2] and Alexander Silverman

ABSTRACT

Beryllium glass has been prepared for the first time, and some of its physical and optical properties have been determined. More than eighty different compositions have been melted and studied. Four series were taken from the clear glass area and examined for density, hardness, refractive index, and ultra-violet light transmission in comparison with magnesium and calcium glasses.

I. Introduction

Beryllium glass is different from ordinary glass only because beryllium oxide is introduced as a new constituent.

Beryllium oxide has not hitherto had widespread use in the industrial field. Considerable experimental work has been done chiefly for the manufacture of incandescent gas mantles,[3] certain light alloys, synthetic gems, and catalysts.

Beryllium oxide has been used in the ceramic industrial field only during the last twenty years.[4] But so far as is known, beryllium oxide has not received any attention as a constituent of glass. The authors are interested in this oxide for two reasons: first, because the element, beryllium has never been studied in glass and may impart useful properties; second, because there are extensive sources of the mineral beryl with practically no commercial use. This preliminary investigation has been made to learn how beryllium glass can be prepared and to study some of its properties.

II. The Theory of Beryllium Glassmaking

Glass is a supercooled solution, and in its simplest form, glassmaking consists in the production of suitable mixtures of alkali and alkaline-earth silicates. In Mendeleeff's "Periodic Table," beryllium is in the same group with magnesium, calcium, and barium, whose compounds have been used in glassmaking. Therefore, theoretically, it seemed reasonable to suppose that beryllium glass could be prepared.

The position of beryllium in Mendeleeff's "Periodic Table" indicates a high melting point, low thermal expansion, etc., a behavior somewhat analogous to magnesium. Its chemical properties, as far as known, resemble aluminum more nearly than any other element.

---

[1] Received May 19, 1928.

[2] Submitted to the Graduate Faculty of the University of Pittsburgh in partial fulfillment of requirements for the degree of Doctor of Philosophy.

[3] Hopkins, Chemistry of the Rarer Elements, p. 90 (1923).

[4] Thomson, English Patent, 2438 of 1915; James, *Metal. Ind.*, **11**, 66 (1917); A. V. Bleininger and F. H. Riddle, *Jour. Amer. Ceram. Soc.*, **2**, 564 (1919).

Beryllium oxide has an advantage over magnesium oxide as a refractory[5] in resisting acid corrosion more effectively. Although the thermal expansion of beryllium oxide is much higher than that of magnesium oxide, it is lower than for oxides of calcium and aluminum. The acidic character of beryllium oxide is weaker than that of alumina but stronger than that of magnesia and lime. It is more basic than alumina and less than magnesia or lime. Beryllium oxide has low density, extreme transparency, high mechanical strength, high electrical resistance, and great hardness, and if these properties could be developed by incorporating beryllium oxide in a glass, the results would hold promise. Beryllium oxide, as a new constituent of glass, has reasonable possibility.

In view of these facts, the authors hoped that beryllium glass could be manufactured as well as ordinary glass and that this glass would have valuable properties, such as extreme transparency, high melting point, and great hardness. In certain cases this has proved to be true.

III. Experimental Work

(A) Preparation of Special Porcelain Crucibles

In order to insure high purity, resistance to corrosion, and capacity to withstand high temperatures, a special crucible was prepared as follows:

	Per cent
Cyanite	25
Tennessee ball clay, No. 5	15
N. C. kaolin	45
Florida kaolin	15

The raw materials were mixed, ground in a ball mill to form a slip and crucibles cast in plaster molds, dried, and fired in gas-fired furnace. The temperature was raised slowly to about 1300°C and held for 3 hours. The furnace was allowed to cool slowly.

IV. Preparation of Beryllium Glasses

(A) Preliminary Study

Beryllium oxide has a high melting point, about 2525°C.[6] The specific gravity unlike that of aluminum oxide, does not change sensibly with ignition and there are no signs of polymerization. The cubical thermal expansion is 4.7×10^{-7} according to Mayer and Havas[7] and its metasilicate has a melting point of about 2000°C. This is the only important available information about this oxide. In order to determine the general melting and cooling effects of beryllium oxide on glass, melts were made and a soda–beryllia–silica diagram

[5] H. B. Weiser, The Hydrous Oxides, pp. 163–64 (1926).

[6] J. W. Mellor, Treatise on Inorganic Chemistry, Vol. IV, p. 222.

[7] Mayer and Havas, *Sprechsaal*, [13], 223 (1911).

prepared. Starting with $Na_2O:BeO:6SiO_2$ a series of glasses was made, in which the Na_2O was kept constant and the amount of BeO and SiO_2 varied. The results are shown in Fig. 1.

Procedure Sodium oxide was introduced as C. P. sodium carbonate; beryllium oxide was introduced directly. The silica was introduced as a high grade quartz, finely ground. The raw batch was placed in a covered crucible, melted in the gas-fired furnace for about nine hours at about 1400–1430°C. The melts were allowed to cool slowly in the furnace for annealing.

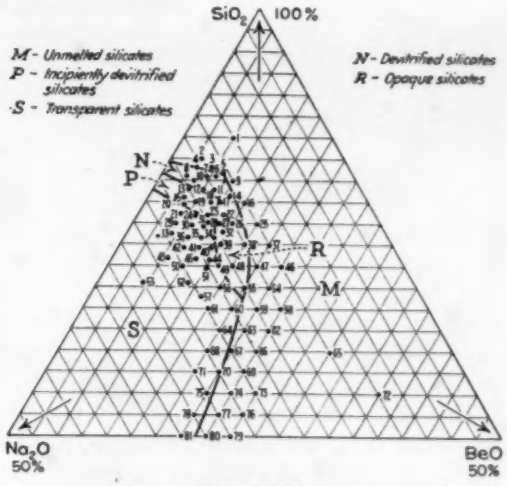

FIG. 1.—Triaxial diagram. (Na_2O–BeO–SiO_2)

Five qualities of glass resulted: (1) unmelted, (2) devitrified, (3) insipiently devitrified, (4) uniformly opaque, and (5) transparent. Their areas on the basis of composition are shown in Fig. 1.

(B) Systematic Study

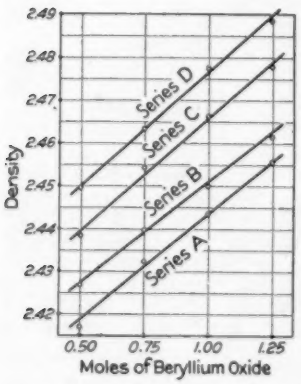

FIG. 2.—Density of beryllium glasses.

Preparation Four series of beryllium glasses for the test pieces were prepared, namely, *A*, *B*, *C*, and *D*, whose compositions are shown in the Table I.

Two hundred and fifty grams of each raw batch were melted as the temperature was raised very slowly to about 1400°–1430° where it was held for about nine hours, when the furnace was allowed to cool to 1100°C for two hours. The crucibles were quickly transferred from the gas-fired furnace to an electric muffle furnace provided with automatic temperature control for annealing.

The annealing was started at 550°C and the furnace cooled to 400°C at the rate of 30°C per hour. Between 400° and 295°C the cooling rate was 15°C per hour, and between 295° and 55°C the rate was 40°C per hour.

The total time required for the annealing of a glass was about 18 hours.

After the annealing and cooling, pieces large enough for grinding and polishing were selected.

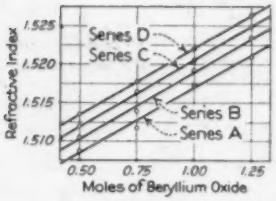

FIG. 3.—Refractive index of beryllium glasses.

Testing Density, refractive index, hardness and the transmission of ultra-violet light were determined.

Density was determined in the usual way by the Archimedes method. The results obtained (mean values) are shown in Fig. 2.

The refractive index was determined with an Abbé refractometer. Results are shown in Fig. 3.

Hardness was measured by a hardness-meter. It was determined by scratching a perfectly plane and finely polished surface by means of the diamond needle, the diamond point being weighted until it produced a scratch wide enough to be seen under the microscope. Minerals such as apatite, feldspar, and quartz were standardized by the hardness-meter and used for comparison. Results are shown in Fig. 4.

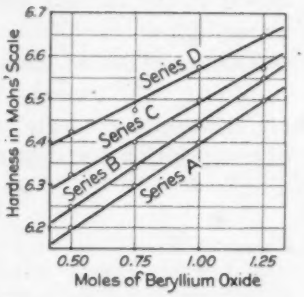

FIG. 4.—Hardness of beryllium glass.

The transmission of ultra-violet light was determined by means of spectrograms. An iron arc was used as a source of ultra-violet light. The limits of transmission of ultra-violet are shown in the spectrograms Fig. 5 and in Table I. The spectrograms here reproduced show one of several sets of groups. Slight variations appear in each set owing to the unsteadiness of the arc. The results in Table I are determined from the average of the several sets.

Results Results of this investigation have been shown in diagrams and figures and may be summarized in Table I.

V. Summary

More than eighty different beryllium glasses have been prepared. These have been distributed on a triaxial diagram to indicate areas of good glass, devitrifiable material, unmelted mixes, etc. in the soda-beryllia-silica group.

Four series were taken from the clear glass area, prepared and examined for density, hardness, refractive index, and ultra-violet light transmission. A calcium and magnesium glass was included in each of the four series for comparison with beryllium glass.

VI. Conclusions

This investigation is novel and original. Pioneer work in this field is time-consuming on account of the preliminary work necessary to

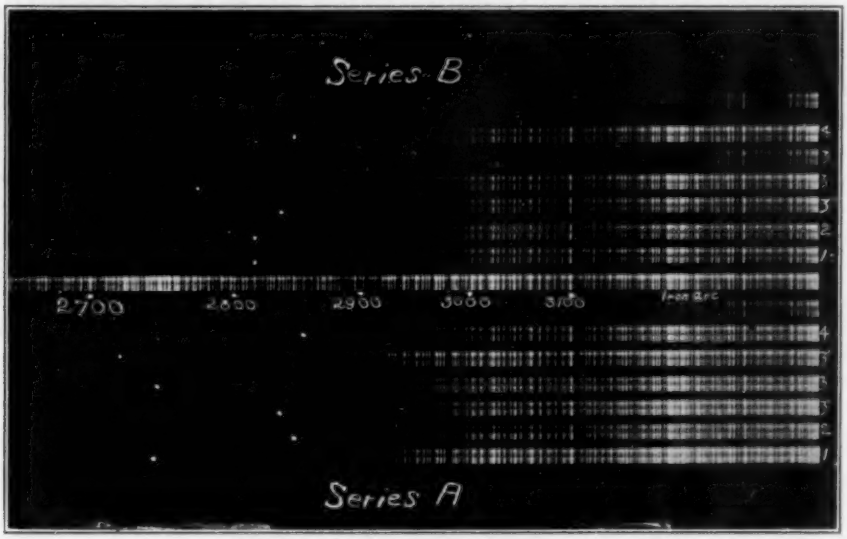

FIG. 5*a*.

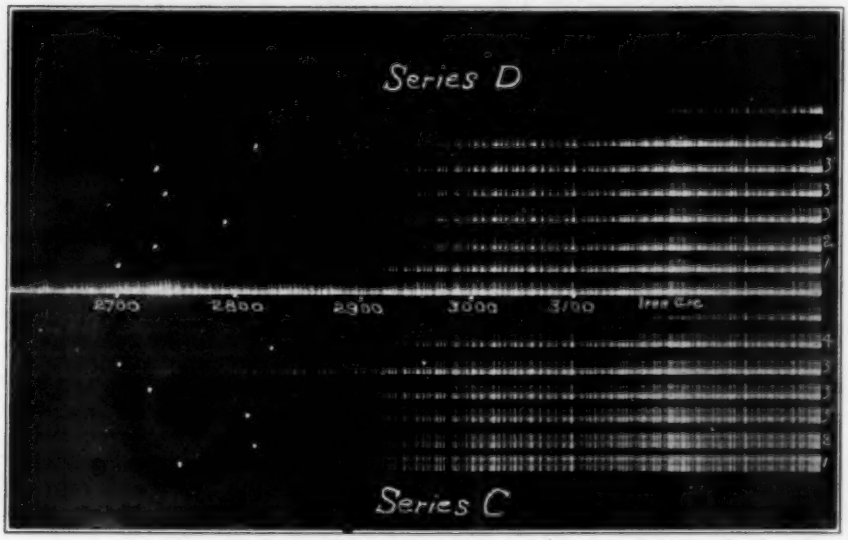

Fig. 5*b*.

prepare the general Na_2O–BeO–SiO_2 diagram before the properties of the individual glasses could be studied systematically. Expensive

equipment and many years of investigation would be required to include all properties. Hence, the testing data furnished are limited. The investigation has, however, paved the way for future work, and the following conclusions and possibilities are noted:

(1) Beryllium glass can be prepared as well as ordinary glass, except that its melting point is a little higher. Beryllium glass melts between 1400° and 1430°C, if the molecular ratio of its constituents Na_2O–BeO–SiO_2 is limited between 1:1:4.25 and 1:1:4 respectively, for good quality glass. When the ratio is 1:1:4.25 the beryllium glass just starts to devitrify. This tendency is greater than in calcium and magnesium glasses. It is evident that beryllium glass is more refractory than either the calcium or magnesium glasses.

TABLE I

SUMMARY OF DATA ON DETERMINATION OF PHYSICAL PROPERTIES

No. of series	Molecular Ratio					Mean Density	Mean Ref. Index	Mean Hardness	Limits of U. V. Light Transmission ($\mu\mu$)
	Na_2O	BeO	MgO	CaO	SiO_2				
A 1	1	0.50	—	—	4.25	2.4168	1.5081	6.200	274
2	1	0.75	—	—	4.25	2.4322	1.5121	6.300	282
3	1	1.00	—	—	4.25	2.4436	1.5173	6.400	283
3′	1	—	1.00	—	4.25	2.4576	1.5136	5.925	279
3″	1	—	—	1.00	4.25	2.5460	1.5391	5.575	289
4	1	1.25	—	—	4.25	2.4556	1.5210	6.500	287
B 1	1	0.50	—	—	4.00	2.4266	1.5107	6.250	279
2	1	0.75	—	—	4.00	2.4396	1.5141	6.345	282
3	1	1.00	—	—	4.00	2.4499	1.5193	6.435	282
3′	1	—	1.0	—	4.00	2.4688	1.5179	6.075	275
3″	1	—	—	1.0	4.00	2.5580	1.5418	5.775	282
4	1	1.25	—	—	4.00	2.4613	1.5237	6.550	284
C 1	1	0.50	—	—	3.75	2.4385	1.5122	6.325	276
2	1	0.75	—	—	3.75	2.4548	1.5165	6.400	281
3	1	1.00	—	—	3.75	2.4667	1.5206	6.500	281
3′	1	—	1.0	—	3.75	2.4715	1.5195	5.700	272
3″	1	—	—	1.0	3.75	2.5616	1.5447	5.575	281
4	1	1.25	—	—	3.75	2.4780	1.5251	6.575	283
D 1	1	0.50	—	—	3.50	2.4491	1.5136	6.425	272
2	1	0.75	—	—	3.50	2.4637	1.5177	6.475	274
3	1	1.00	—	—	3.50	2.4787	1.5222	6.575	274
3′	1	—	1.0	—	3.50	2.4906	1.5211	5.875	274
3″	1	—	—	1.0	3.50	2.5810	1.5474	5.425	282
4	1	1.25	—	—	3.50	2.4885	1.5265	6.650	282

(2) The annealing of beryllium glass, within the limits mentioned, has not shown any particular difficulty.

(3) In density, beryllium glass is lower than the corresponding calcium and magnesium glasses, but it shows an increase with beryllium oxide content. Density is a straight line function.

(4) In hardness, the beryllium glass greatly exceeds soda-lime glass, and is greater than magnesium glass. Hardness does not increase much with an increase in the beryllium oxide content. The glasses are harder

than feldspar and softer than quartz. For the glasses examined hardness lies between 6.2 and 6.7.

(5) The refractive index of beryllium glass is slightly higher than for magnesium glass but much lower than for calcium glass. Adding beryllium oxide increases the refractive index which is a straight line function of beryllium content.

(6) In transmission of ultra-violet light, beryllium glasses show a greater value than ordinary glass, but less than magnesium glass. The ultra-violet transmission decreases with increased beryllium oxide content and the purity of raw materials seems important. The varying results obtained in this investigation indicate a need for further research.

Beryllium glass, generally speaking, can be manufactured as well as ordinary glass, except for high cost of beryllium oxide. Some of its physical properties, may make it desirable as an optical glass. If hardness alone is required in commercial glasses, beryllium may be introduced as beryl which is quite cheap and also contains aluminum which toughens glass.

Acknowledgments

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THE REQUISITE CONSISTENCY FOR A CASTING SLIP[1]

By Walter L. Shearer[2]

ABSTRACT

Producing desirable flowing quality in a slip is proposed as a means of controlling its casting quality. A conception of plastic flow as a property incapable of being measured in terms of an absolute unit such as may be applied to viscosity measurement is presented and a simple gravity flow, tube consistometer of suitable dimensions for obtaining comparative tests upon casting slips or upon similar suspensions is described.

Only sufficient data are presented to aid in explaining or describing general principles or conceptions, to suggest means of obtaining desirable plastic flow and to show what the consistency of a vitreous sanitary ware casting slip now in use actually is. Stiffness, yield value, and starting pressure are regarded as the elements making up plastic flowing quality and it is necessary to take all three of these factors into account in order to specify the kind of flow obtained. The consistency of a casting slip which will produce good solid cast ware, described in terms of the test apparatus used in connection with this work, may be stated as follows: stiffness equals 60 cm. per cc. per sec.; yield value equals 20 cm.; plasticity ratio equals 2.5. Reference has also been made to the application of these same principles to the control of glaze slips and to the testing of clays to determine their suitability for use in any process involving their plastic working properties.

Introduction

In most ceramic processes and in all of the whiteware industries a suspension of body or glaze materials in water must be handled. It is recognized by those working with any such slip that it must have a certain consistency in order to produce a desired result. This consistency is particularly important in connection with the making of ware by the casting process such as is now in use throughout the vitreous sanitary ware industry. In the past the consistency has often (although erroneously, according to the strict technical application of the term) been referred to as viscosity.

As a matter of fact the flowing quality of such a suspension under the usual circumstances should more properly be called "plastic." Aside from any practical value it is desirable from a scientific point of view that suitable terms be used to distinguish specifically the kind of flow under consideration. Viscous flow, in the true sense of the term, is exhibited by fluids which are homogeneous in nature considering particles no smaller in size than those of molecular dimensions. Thus truly viscous flow obtains in the case of water or in the case of an oil flowing under conditions where no eddy currents are set up. Plastic flow is found in the case of a heterogeneous mixture such as clay or other solid particles suspended in water or in general where different sized particles are suspended in a homogeneous liquid.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., Feb., 1928. (White Wares Division). Received March 29, 1928.

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Relation of Viscous to Plastic Flow

Viscous flow is often referred to as straight line flow because of the following conception of its mechanism. Considering the flow of a liquid through a capillary tube, there is in the first place a pressure applied which causes the flow. At the wall of the capillary there is a layer of adsorbed liquid which is stationary; the successive layers of liquid at increasing distances from the capillary wall toward the center of the tube move in a direction parallel to the axis of the tube at successively greater speeds so that those particles which move through the center of the tube have the greatest linear velocity. As long as nothing interferes with the flow in such a way as to produce eddy currents the molecules composing any given layer move at a speed corresponding to the distance of their layer from the wall toward the axis of the tube. There is thus established a distance rate of change of speed from the wall to the center of the tube. The viscosity of the liquid may be defined as the average shearing stress divided by the average distance rate of change of speed or as the shearing stress at the capillary wall divided by the distance rate of change of velocity at the wall; or expressing this statement in the form of an equation

$$\frac{dv}{ds}=\frac{F}{\eta}$$

where dv/ds represents the distance rate of change of linear velocity through the tube between successive layers at and next to the tube wall, F, the shearing stress at the wall, and η the viscosity.

Upon integration of this equation which defines viscosity, and leaving out of consideration slight corrections for kinetic energy absorbed by the material being set in motion and for capillary attraction in the flow tube, it is found that the observed rate of flow may be represented by the equation

$$\frac{V}{t}=\frac{\pi r^4 p}{8l\eta}$$

where V/t is the rate of flow in cc. per sec., p is the pressure in dynes per sq. cm., r and l are respectively radius and length of the flow tube in cm., and η the viscosity in poises. Where the pressure, p, is developed by the height of a column of liquid, $p=h\delta g$, h being the height of the column of slip in the tube above the lower end of the capillary in cm., δ the density of the slip in g/cm.^{3}, and g the gravity constant (981 dynes/g.).

In order to represent graphically the relationship whereby viscosity is measured, the pressure, p, may be plotted against the rate of flow V/t, and it will be possible to connect the plotted points by a straight line which will go through the origin: the deformation or flow is directly proportional to the deforming force. See the curve marked

"viscous flow," Fig. 1. The slope of this line refers to the rate of flow axis, $p/V/t$, multiplied by the constant $\pi r^4/81$, which is dependent only on the size of the capillary flow tube used, and is the viscosity of the liquid. Viscosity is thus a property with a definite absolute unit and this property may be measured by observing different rates of flow corresponding to various pressures using any flow tube of sufficiently small diameter and long length to prevent the flow from becoming so rapid that turbulence is induced or so rapid that the application of troublesome kinetic energy corrections becomes essential. With results plotted as shown in Fig. 1 where the height is used as the measure of the pressure, the slopes of the curves obtained for different viscous liquids flowing through the same capillary tube are directly proportional to the kinematic viscosities of these liquids, kinematic viscosity being the true viscosity divided by the density.

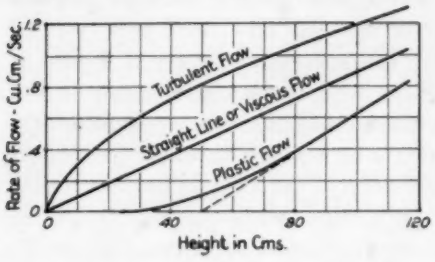

FIG. 1.—The simplest method of recording results of observations to determine the type of flow obtained. In order that results be directly comparable the same flow tube must be used for all tests.

Stiffness = 110 − 50/.74 = 81
Yield value = 50 cm.
Starting pressure = 30 cm.
Plasticity ratio = 50/30 = 1.7

If for the liquid under observation the flow tube used has too short a length or too great a diameter, eddy currents will establish themselves, and the pressure rate of flow curve then found will have the general shape of the one marked turbulent flow, Fig. 1.

In place of plotting pressure, p, along the horizontal axis, corresponding values of shearing stress at the tube wall, $\pi r^2 p/2\pi rl = rp/2l$ dynes per cm.^{2}, may be used together with corresponding values of distance rate of shear at the tube wall, $4V/\pi r^3 t$ cm./sec./cm., plotted along the vertical axis in place of values of rate of flow, V/t. The curve will then occupy a position such as that shown in Fig. 2 and this position will be the same for a

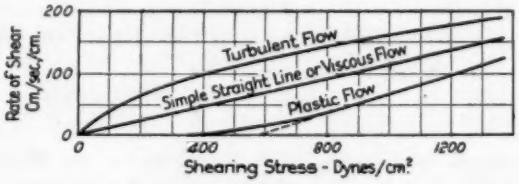

FIG. 2.—Method of plotting results of observations made upon a homogeneous liquid at a constant temperature with any size of flow tube within the workable limits, whereby the position of the viscous-flow curve is independent of the tube used in making the determination. Where turbulent or plastic flow is found the position of the curve can not be expected to be entirely independent of the size of tube used.

given homogeneous liquid at a given temperature regardless of the dimensions of the tube within the workable limits. These workable limits are set by the production of turbulence or the necessity of applying corrections of too great an order of magnitude on the upper side and the difficulty of properly cleaning the tube and the inconveniently long time required for making observations on the lower side.

Ceramic Application

Using the same flow tube observations may be obtained upon a heterogeneous mixture such as a suspension of clay, flint, and feldspar grains in water or in dilute water solution instead of upon a homogeneous liquid of a truly viscous nature such as a heavy oil. Certain clay-flint-feldspar suspensions with the solid grains in the proper state of deflocculation are of course casting slips. A typical curve for one of these suspensions may have the general trend of the one labeled "plastic flow," Fig. 1, or its equivalent in Fig. 2. Referring to the curve as produced by the simpler method of plotting of Fig. 1 it will be noticed that at the higher pressures it is sensibly a straight line which at the lower pressures and corresponding rates of flow bears off toward the origin. Three separate characteristics of this flow curve may be noted and defined and these may be regarded as the factors making up the plastic flowing quality of the particular slip being tested.

Factors Determined from the Plastic Flow Curve

No attempt is made in connection with this work to develop an equation for plastic flow. It is far simpler and easier merely to record the facts for each case by means of a graph. In order to provide a means for statistical analysis of various flow curves, four separate characteristics or factors which are shown directly by any flow curve may be enumerated.

The upper straight portion of the plastic flow curve may be projected down to meet the abscissa or pressure axis. The shearing stress indicated by this point of intersection has been named by Bingham,[3] the yield value. The shearing stress is, of course, proportional to the pressure or for a given slip proportional to the height or head of the fluid and in this paper the simplest possible procedure is adopted by plotting the fluid head directly in place of the pressure or the shearing stress. Unless otherwise stated the term "yield value" as used here refers to this intersection on the horizontal axis measured in terms of centimeters of height of the slip being tested. Herschel and Bulkley[4]

[3] E. C. Bingham, Fluidity and Plasticity, New York (1922), pp. 4 and 215.

[4] W. H. Herschel and R. Bulkley, "Calibration of a Buret Consistometer," *Ind. Eng. Chem.*, **19**, 134 (1927); "Measurement of Consistency as Applied to Rubber Benzene Solutions," *Proc. A.S.T.M.*, **26**, [II], 621 (1926).

have suggested that the term "stiffness" be applied to the angle measured by the slope of this straight line as referred to the vertical axis. Stiffness of a plastic flowing fluid is thus measured in the same terms as viscosity of a liquid exhibiting simple straight line flow, *viz.*, in the present instance in terms of a unit which has the dimensions of cm. of height of column of slip per cc. per second rate of flow through the tube used for making the test. A slip is "thicker" or of a "heavier consistency" if either yield value for a given stiffness or stiffness for a given yield value is greater.

The apparent intersection of the flow curve itself with the horizontal or pressure axis may be designated as the *starting pressure*. The determination of the value of this starting pressure in a practical way is attended by difficulty and is open to criticism on account of the fact that with a simple apparatus and without expending a very great amount of time it is impossible to determine points on the curve at the lowest rates of flow so that a curved line must be extrapolated to meet the axis. Nevertheless in spite of the considerable error possible in a determination of this kind the slips dealt with are such that for the apparatus suggested the probable error is not very great and starting pressure may be defined and used as the result obtained in this way. It will also be found convenient for the purpose of comparing different slips to designate the ratio, yield value to starting pressure as the plasticity ratio.

It is possible that the straight portion of the plastic flow curve appears only because of counterbalancing conditions governing the flow of the particular slip through the particular tube used. If all the appropriate corrections are applied, the pressure-rate of flow curve may in all cases take the form of a parabola with its nose cut partly off by the pressure axis and in this case there would be theoretically no yield value at all unless yield value be spoken of as infinite. Herschel and Bulkley have proposed a suitable empirical exponential equation as the best means of representing the plastic flow of rubber-benzene solutions, the constants found from the equation to be taken as the measure of the plasticity. In connection with the present work, however, no time has been available to attempt to apply all of the corrections which might be suggested and then to attempt to make a more exact mathematical interpretation of results, and this work is presented here without more rigorous tests having been completed because it appears that results of considerable practical value are obtainable in the simple manner outlined.

If the graph for the plastic flow is made by plotting shearing stress against rate of shear according to the method shown in Fig. 2, as was done in the case of the oil taken as an example of a material showing viscous

flow, the curve obtained will have the same general shape as it has in Fig. 1. If the determination is made with a flow tube of slightly different radius or of slightly different length and both sets of results are plotted as shearing stress against rate of shear the results do not necessarily fall on the same line as was noted to be the case when testing the oil. A graph showing a typical degree of agreement, as obtained in one set of experimental results, follows (Fig. 6). A large number of plasticity determinations on different slips and with different sized tubes have been run and on the whole these show that while in the case of some slips the flow or plasticity curve as determined with one tube completely coincides with the curve as determined with another whose dimensions are not widely different, in the cases of many other slips tested with the different tubes variations are observed first in one direction and then in the other.

The general conclusion reached regarding this plastic régime of flow is that there is a certain amount of turbulence occurring around each of the suspended particles; that this degree of turbulence with a suitable tube approaches a constant or steady state that does not interfere with the nature of the flow as a whole, as the existence of comparatively large eddy currents does; and that although this steady state of turbulence is primarily dependent upon the degree of deflocculation of the slip it is also dependent upon the dimensions of the tube. From observations of many of these slips this would seem to be a more plausible explanation of the existing state of affairs than the solid plug idea, the mathematical implications of which were developed by Buckingham.[5] It is in consequence deemed desirable to use a tube of suitable dimensions for the work in hand and for the sake of comparison to obtain all results with this one size of tube.

Field Covered

Results obtained to date indicate that if the proper relationship is maintained between yield value, stiffness, and starting pressure together with suitable absolute values for these constants, as suggested by the following curves and tables, the casting slip will produce good solid ware and that if these conditions shown by the flow curve of the slip are not maintained, ware may be produced showing cracking, balling, varying shrinkage, or perhaps other defects. It will be found for instance that a low yield value is associated with such properties as low plasticity or "shortness" of the body in the plastic state when it is worked by hand, a tendency toward "settling out" of the larger

[5] E. Buckingham, "On Plastic Flow through Capillary Tubes," *Proc. A.S.T.M.*, **21**, 1154 (1921).

grains as a hard compact mass at the bottom of the deflocculated or dispersed slip, slower rate of loss of water into the mold or longer time of casting, surface scums on the slip and cast piece, low drying shrinkage, etc., but the caution must be expressed that yield value alone does not tell the whole story; the other factors shown by the plasticity curve must be taken into consideration at the same time. The phenomenon of settling out accompanies deflocculation and is to be differentiated from the opposite effect of settling which accompanies flocculation. In the process of settling there is no segregation. The body as a whole settles leaving a clear supernatant liquid. A slip which simply settles shows a high yield value as opposed to the low yield value of one which settles out. A considerable degree of correlation appears to exist between plasticity ratio considered along with the other plastic flow factors and the soundness of the casting the slip will produce.

The scope of this paper is primarily confined to presenting a useful design of apparatus for testing slips and to pointing out general principles which appear to obtain, making particular application to the field of vitreous sanitary ware casting. The same sort of test, however, may be applied to glaze and other more dilute slips. For instance Cooke[6] has shown that adding water to an enamel slip lowers its yield value and stiffness, that increasing the temperature has a similar effect, and that adding different salts produces different effects according to the specific nature of the salt used. Following up this work Harrison[7] has recently published the results of a considerable number of tests of enamel slips applying the plasticity curve to the making of changes so as to produce more desirable and better controlled working quality. Hall[8] has shown the application of this method to the determination of the relative plasticities of clays. He used the Bingham plastometer apparatus making readings of rate of flow under different carefully controlled pressures and his results also clearly show the existence of the starting pressure factor, although he has not given it much consideration.

The testing of various clays in this way in order to determine their suitability for any given use is a field offering promising possibility of development. A material like halloysite or many a china clay when in the ordinary plastic state is stiff or "stays put" when deformed; in slip form it shows a high yield value and high starting pressure for a given

[6] R. D. Cooke, "The Plastic Properties of Enamel Slip," *Jour. Amer. Ceram. Soc.*, **7** [9], 651 (1924).

[7] W. N. Harrison, "Vitreous Enamel Slips and Their Control," *Ibid.*, **10** [12], 970 (1927).

[8] F. P. Hall, "Methods of Measuring the Plasticity of Clays," Bur. Stand., *Tech. Paper*, No. 234 (1923).

stiffness. A good dark ball clay on the other hand characteristically has about its workability a certain amount of springiness and ability to spread out without cracking; in slip form for a given stiffness it shows a rather high yield value together with low starting pressure, *i.e.*, a high plasticity ratio. Plastic flowing quality appears to be made up of these individual factors all taken together and a different kind of plasticity is observed according to whether the plasticity ratio is low or high, a different amount or degree of plasticity according to whether the yield value for a given stiffness is low or high.

Gravity Flow Tube Consistometer

Figure 3 shows the apparatus which has been developed as, on the average, the most satisfactory for the purpose of testing suspensions having consistencies approximating those found for the body slips in common use in the vitreous sanitary ware industry. There is also included in this illustration the drawing of a brass tube of smaller diameter and greater length (.2391 by 17.23 cm.) which may be placed inside of the larger flow tube in order to provide an apparatus suitable for the testing of glaze or enamel suspensions or of clay slips of similar consistency. A glass tube (approximately 2.3 by 145 cm. inside) as uniform in diameter as it is possible to obtain, is fitted with a brass flow tube 15.73 cm. long, 0.4114 cm. diameter of bore. The glass tube is marked off into 7 spaces of varying volume such that for a liquid showing the truly viscous type of flow and no turbulence the average pressure at the bottom of the flow tube during the time of passage of the top of the column of liquid from the upper to the lower mark for a given space, is directly proportional to the volume of that space.[9] This means that for a truly viscous flowing material the time

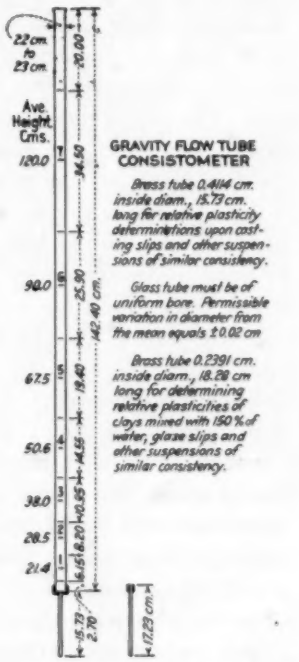
22 cm. to 23 cm.
Ave. Height Cms.
120.0
90.0
67.5
50.6
38.0
28.5
21.4
GRAVITY FLOW TUBE CONSISTOMETER
Brass tube 0.4114 cm. inside diam., 15.73 cm. long for relative plasticity determinations upon casting slips and other suspensions of similar consistency.
Glass tube must be of uniform bore. Permissible variation in diameter from the mean equals ±0.02 cm
Brass tube 0.2391 cm. inside diam., 18.28 cm long for determining relative plasticities of clays mixed with 150% of water, glaze slips and other suspensions of similar consistency.
15.73 cm.
17.23 cm.

FIG. 3.—The volume of each of the seven spaces is determined by calibration.

[9] The different heights on the glass tube are calculated from the formula $h_{av}=h_1-h_2/ln\ (h_1/h_2)$ where h_{av} = the average height of the space whose upper and lower bounding marks are at heights, h_1 and h_2, respectively. This formula is derived from the equation $\Delta V/\Delta t=ah$ where ΔV is the volume delivered from the average height, h_{av}, through the flow tube in the time, Δt, a being a constant, by substituting for ΔV its value in terms of h and integrating between the limits h_1 and h_2. In dealing with a

of flow for the second and all other spaces is the same as the time of flow for the first. Then when a plastic material is tested these times of flow for successive spaces are successively greater according to the degree of plasticity of the slip. If turbulence is encountered the times of flow for successive sections are successively less. For a clay body suspension when this latter effect is observed the slip is apt to be one which will allow settling out or segregation of the larger solid particles.

In using the apparatus a rubber cap is placed over the bottom of the clean dry flow tube and the glass tube is filled with well-stirred slip. An electric light is placed just above the top of the tube so as to reflect light from the surface of the slip in the tube and make it possible to see the position of this surface clearly through the slip-coated glass wall. The cap is removed from the bottom of the flow tube and the surface of the slip in the glass tube begins to drop. As this surface passes the top mark on the graduated glass tube the stop-watch is started. It is by far preferable to use a "split second" timer so that all seven time-intervals can be clocked for the seven spaces marked off on the tube without inconvenience; otherwise two stop-watches may be used or else only four time-intervals can be determined in a single run with one stop-watch. As the level of the slip passes the second mark on the tube, hand No. 2 of the stop-watch is stopped while hand No. 1 continues uninterrupted. After taking the reading for space No. 7, the stem controlling hand No. 2 is pressed allowing this hand to again continue along with hand No. 1. Hand No. 2 is again stopped at the end of space No. 6 and so on down the tube. The time for each individual space is found by difference and each volume is divided by the corresponding time. This quotient is the average rate of flow which is plotted against the corresponding average head in order to determine the plasticity curve.

This apparatus is designed with the purposes in mind of reducing the necessary number of readings and calculations to a minimum and the necessary amount of time to a minimum while at the same time

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plastic flowing material the average heads will not be the same as for a viscous flowing material but will be lower as the amount of plasticity is greater and this effect will be relatively more prominent as the space under consideration is nearer the bottom of the glass tube. Herschel and Bulkley[4] have described a means of ascertaining the average head in the case of a plastic material. The use of this method is avoided here in order to eliminate the complicated procedure (which involves using a different head for the same space for each fluid of different plasticity) since it appears to be possible to obtain practically useful results without making these corrections. The amount of error is minimized by having spaces over which times are clocked shorter as the lower part of the tube is approached.

avoiding the necessity of making corrections to the simple observations in order to obtain practically useful results. Although the obtaining of the necessary data is an easy and simple matter the manipulation must be carefully carried out for the mislocation of one or two points on the plasticity curve may give rise to the appearance of a different type of flow than the actual one.

Before making any test upon a clay or clay body slip it should be thoroughly and uniformly stirred before it is placed in the consistometer and the test should then be immediately started, in order to deal uniformly with the effect which has been named thixotropy.[10] All testing should be done at the temperature at which the slip is to be used since change in temperature will noticeably alter plasticity. It is also important that the heat treatment accorded the slip should be the same as that represented by any temperature changes which it regularly undergoes in the plant process. If the slip is mixed warm and then used at a somewhat lower temperature, experimental batches should be tested only after they have undergone the same temperature changes. After a gel structure is destroyed the dispersed condition commonly continues to exist at a lower temperature than that required to break it up. Finally the walls of the flow tube must be thoroughly clean and dry before the slip is placed in the consistometer. This point can hardly be overemphasized. Oil films as well as water films are apt to adhere to the brass tube walls. Clay or body slip flowing through the tube or rubbed upon its walls is one of the best cleansing agents. Drying can be done with a clean cotton swab on the end of a wood splint.

Consistency Determination as Measure of Degree of Deflocculation

Figure 4 and Table I show a set of results obtained with different percentages of water in a slip deflocculated with sal soda and tannin. All percentages used throughout this paper are based upon dry body weight. With 0.48% soda and 0.12% tannin and 39.9% water the slip showed a flow curve which for a stiffness of 54 cm. per cc. per sec. had a yield value of 19.5 cm. and a starting pressure of 24.0 cm. The plasticity ratio was therefore $19.5/24.0 = 0.8$, a very low figure. This is undesirable indeed for a casting slip; the curve actually bends away from the origin at the lower pressures. The pieces cast from the slip were very badly balled and the sides were sucked inward.

In order to give the slip better flowing qualities the percentage of tannic acid was increased to .15%. The plasticity curve then approached a more usual trend and occupied the position shown at 17*b*. Even with slightly less water present the stiffness was less. The

[10] H. H. Stephenson, "A Note on Thixotropy in Clays," *Jour. Amer. Ceram. Soc.*, **10** [11], 924 (1927).

plasticity ratio became 1.4 which is a considerably better figure and although the cast pieces showed bad balling at some places they were solid at other places. The slip was next merely diluted by the addition of 1.6% more water. While this change brought about a marked decrease in stiffness neither yield value nor starting pressure was greatly altered and the plasticity ratio increased to only 1.7. The cast pieces were still badly balled and the sides were sucked inward although the condition was not as bad as in the case of slip 17*a*.

Upon further dilution of the slip with 3.7% more water and further stirring the plasticity became that shown by curve 17*d*. The stiffness decreased to only 14.4, the yield value decreased slightly to 19.0, and the plasticity ratio showed a large increase to the high value of 3.8. This slip produced cast pieces which were satisfactorily solid, the sides not being sucked inward at all, although a slight amount of balling was apparent. The transverse strength of the test pieces which were dried at 110°C was constant and uniform at about 450 lb. per sq. in. The linear drying shrinkage was 4.1% in place of the 4.5% found with slip *c* and the 4.4% with slip *b*.

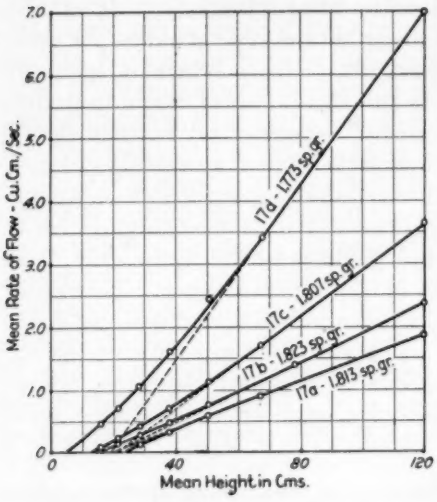

FIG. 4.—Variation in type of flow attained by increasing tannin content and by increasing water content. (See Table I.)

In general it is found that a decided decrease in yield value is accompanied by a decrease in drying shrinkage. It would not necessarily be advisable to attempt to decrease shrinkage by decreasing yield value beyond a certain point, however, on account of thereby inviting other difficulty arising from the means employed to make the adjustment. Thus adding more deflocculating salts thereby cutting down yield value and drying shrinkage will not always diminish warpage tendency on account of the increased amount of solid material likely to be drawn to the surface upon drying. A proper balance for the body used must be struck and usually there is a shading off from good to bad without the appearance of any definitely established line of demarkation.

The improvement in the casting qualities noted above for slip *d* is not necessarily due alone to having more water in between the solid body particles. With the greater amount of water present the slip was

more readily stirred and completely mixed so that the tannin and soda present together with the naturally occurring deflocculating salts had better opportunity of becoming effective. Expressed in other terms it might be said that there was a breaking up of the gel structure and that this then did not tend to re-form. The process of deflocculation is rather a complicated one and it must also be remembered that the different chemical reactions which may occur all have their own time-rates.

TABLE I (See Fig. 4)

Slip No.	17*a*	17*b*	17*c*	17*d*
Per cent hydrated sodium carbonate	.48	.48	.48	.48
" " tannic acid	.12	.15	.15	.15
" " water	39.9	38.7	40.3	44.0
Specific gravity	1.813	1.823	1.807	1.773
Calculated true sp. gr. of body	2.693	2.685	2.679	2.693
Stiffness (cm./cc./sec.)	54	42	26	14.4
Yield value (cm.)	19.5	20.5	22.0	19.0
Starting pressure (cm.)	24.0	14.8	13.1	5.0
Plasticity ratio	$\frac{19.5}{24.0}=.8$	$\frac{20.5}{14.8}=1.4$	$\frac{22.0}{13.1}=1.7$	$\frac{19.0}{5.0}=3.8$
Per cent linear drying shrinkage	4.8	4.4	4.5	4.1
Transverse strength, dried at 110°C (lb./sq. in.)	170 ± 40	440 ± 70	370 ± 60	450 ± 20
Condition of test piece	Very badly balled. Sides sucked inward	Bad balling to solid	Slight cracking and balling. Sides sucked inward where solid	Solid to very slight balling at points far from pouring funnel

Brass flow tube = 0.4102 × 11.2 cm.

Determinations on filtrate removed through an alundum filter cup from slip 17*d*:

p_H value = 8.4

Surface tension = 62.6 dynes/cm.

Color = amber, rather dark yellow

Solids per 100 cc. = 0.310 g.

The filter cake obtained on an alundum filter was soft and flowed easily. It had fair plasticity when worked by hand in the ordinary plastic condition.

Transverse strength of test pieces pressed from this filter cake, dried at 110°C = 480 ± 10 lb. per sq. in.

Linear drying shrinkage = 3.8%

There is a very marked time effect apparent in the process of deflocculating this slip. For instance when slip 17*a* was first mixed it was very thick, almost pasty. After standing about one-half hour it thinned up to a very great extent so that it could be readily stirred. In this condition the addition of more sodium carbonate solution appeared to flocculate it whereas the addition of more tannin solution made it flow very well.

This experiment is presented here because it illustrates characteristic changes and it is suggestive of underlying causes for clay slips acting as they do. The deflocculating action of tannic acid has been pointed out. This material was used because it is analogous to the organic substances occurring in many ball clays. The literature records the observation that ball clays used in a slip impart to it "flowing quality."[11]

[11] A. C. Gerber, "Casting Control," *Jour. Amer. Ceram. Soc.*, **8** [1], 18 (1925). E. H. Fritz and A. L. Donnenwirth, "Casting of Heavy Electrical Porcelains," *Jour. Amer. Ceram. Soc.*, **8** [9], 547 (1925).

This work should more definitely indicate what is meant by flowing quality. Obviously good flowing quality results from relatively low yield value and especially low starting pressure.

Plasticity of Vitreous Sanitary Ware Slip for Solid Casting

A typical flow-curve found for a casting slip in successful use commercially (designated here as Slip *A*) may now be examined. This slip is deflocculated with the ordinarily used deflocculants, sodium carbonate and sodium silicate. The curve marked "unadjusted" in Fig. 5 refers to the slip as first mixed. This slip was regarded as being slightly too heavy for use in the casting shop. The water content as calculated from the specific gravity was 31.8%, the stiffness 112, and the plasticity ratio 2.0, with a yield value of 27.5. When cast into test molds the slip produced pieces showing extremely slight balling tendency and good transverse strength, approximately 360 lbs. per sq. in. In order that it flow a little more readily for use in the shop it was adjusted by the addition of a solution containing a sufficient amount of deflocculating salts to increase the amount already present by about 10%.

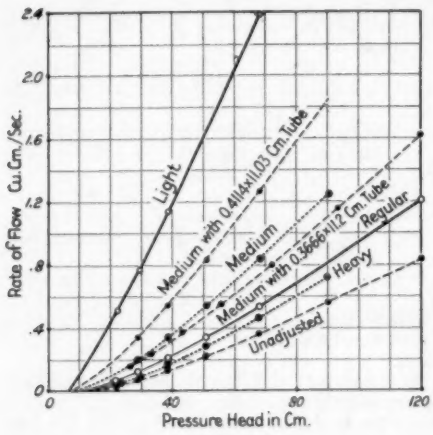

FIG. 5.—Simplest method of showing consistency of a casting slip as determined with a flow tube 0.4114 cm. inside diameter by 15.73 cm. long. Positions of the plasticity curves as determined for the "medium" slip with two other flow tubes are also shown. (See Table II.)

The slip then had the flowing properties designated by the curve marked "regular." The test pieces looked good and solid although upon breaking them a slight amount of balling did appear at some places. This balling was so slight that the dry strength of those cast test pieces showed that it was as good as the dry strength of other test bars which when broken appeared perfectly solid. The linear drying shrinkage was 2.9%, nearly the same as the 3.0% found for the unadjusted slip. It will be seen that the adjustment produced a slip with a stiffness of 76, yield value of 27.0, starting pressure of 11.2, and plasticity ratio of 2.4.

A small batch (about 8 lbs.) of the regular slip was taken to the laboratory and after standing well covered for two days it was thoroughly stirred up and tested at three different dilutions and at each of these dilutions with three different flow tubes. The slip in the con-

dition labeled "heavy" had lost a slight amount of water by evaporation during stirring and handling, the water content being 31.2%. The plasticity curve (marked "heavy," Fig. 5) as compared with the plasticity curve for the regular slip showed a higher yield value and a starting pressure increased to a relatively greater extent, the plasticity ratio thereby being decreased to 2.1. The cast test pieces showed a tendency toward balling and their sides were markedly curved inward. The drying shrinkage was slightly higher, 3.1%. With the water content

TABLE II (See Fig. 5)

Slip A	Unadjusted	Regular	Heavy	Medium	Light
Per cent water		32.0	31.2	32.5	36.5
Specific gravity	1.877	1.871	1.883	1.864	1.820
Calculated true sp. gr. of body		2.598	2.600	2.598	2.600
Stiffness (cm./cc./sec.)	112	76	90	55	21.6
Yield value (cm.)	27.5	27.0	25.7	21.5	15.6
Starting pressure (cm.)	13.5	11.2	12.3	10.0	5.8
Plasticity ratio	2.0	2.4	2.1	2.2	2.7
Per cent linear drying shrink.	3.0	2.9	3.1	3.0	2.7
Trans. strength, dried at 110°C, (lb./sq. in.)	360±10	350±10	440±30	440±20	400±10
Condition of test piece	Extremely slight balling tendency	Very slight balling at points far from pouring funnel	Slight balling tendency and sides slightly sucked in	Very slight balling tendency	Solid

Consistencies, except those noted for comparison, are determined with a 0.4114× 15.73 cm. tube.

Determinations on filtrate removed through an alundum filter cup from "heavy" slip:

p_H value = 8.6
Surface tension = 68 dynes/cm.
Color = light straw yellow
Solid per 100 cc. = 0.272 g.

The filter cake obtained on the alundum filter cup showed poor plastic working properties when shaped by hand; it was "short."

Transverse strength of test pieces pressed from this filter cake, dried at 110°C = 530±30 lb./sq. in.

Linear drying shrinkage = 2.8%. Water content of this plastic worked filter cake = 19.4%

Water content of solid cast test pieces as removed from the mold, average = 20.8%.

Data obtained on the filtrate through the alundum filter cup represent properties of the liquid which may be removed from the slip. It is the layer of clay body first deposited on the cup that is the real effective filtering medium since its pore spaces must be smaller than those of the filter cup. As judged by the relative speeds of penetration, the resistance offered by the filter cup to the passage of water is almost negligible in comparison with the resistance offered by the clay coated cup to this passage of water.

next increased to 32.5% this sucking in of the sides was eliminated although a very slight amount of balling was apparent. The transverse strength of the body dried at 110°C was good, 440 lb. per sq. in.

Upon further dilution to a water content of 36.5% the slip was of such thinness that the point at which the coarser particles of flint and feldspar begin to settle out appeared to be close at hand. The yield value and the starting pressure had decreased but the plasticity ratio had slightly increased to 2.7. The cast pieces were solid and of good

uniform strength and the shrinkage had been reduced to 2.7%. Such a slip is too thin, however, for ordinary factory use on account of the possibilities of slight segregation and of leakage from cracks in the molds. Settling out is always apt to occur wherever the yield value of the slip is very low.

This slip *A* with the regular amounts of water and of deflocculating salts had casting properties which made it a satisfactory commercial slip. Two other vitreous sanitary ware slips which were reported as working very well at their respective plants in the Trenton district were found to have flowing properties or consistencies very close to those of this slip. Slip *A* could, however, be bettered for general plant use as far as the elimination of balling is concerned by using in making the adjustment slightly more water and less silicate in order to obtain a slip with a plasticity ratio of about 2.6 as shown by a plasticity curve which would lie in between those marked "regular" and "medium" in Fig. 5. No change should be made in a slip such as slip *A* which would result in a diminished plasticity ratio. In an attempt to decrease stiffness and yield value keeping this condition in mind it might be found advisable to bring into use other deflocculating salts than carbonate and silicate. A rather low yield value (preferably obtained in many cases by using a higher water content) appears to be more desirable for accomplishing drain casting than for solid or core casting.

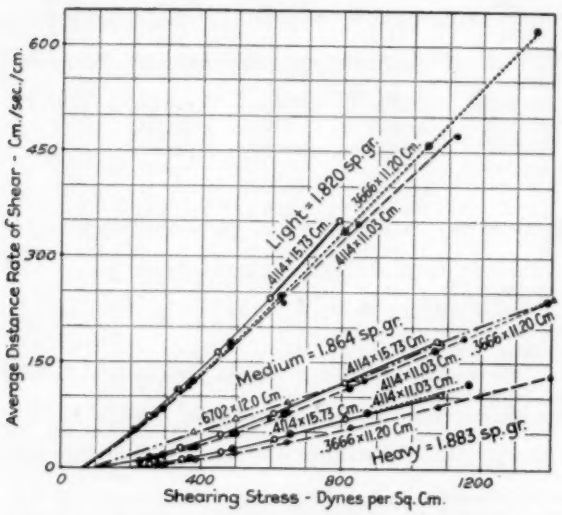

FIG. 6.—Slightly and irregularly different plastic flow characteristics are found for the same slip according to the flow tube used in making the determination. Slip *A*; consistencies at different dilutions showing degree of agreement of determinations, as made with different flow tubes.

Comparison of Determinations Made with Different Sized Flow Tubes

Figure 6 shows the results of plasticity tests made upon slip *A* with different sized flow tubes. Shearing stress is plotted against average rate of shear at the tube wall in order to eliminate if possible by this

means the effect of size of tube used upon plasticity factors. It will be seen that it is impossible to do this except to an approximate extent with these slips, for the curves found with the different tubes do not exactly coincide in every instance. These results seem to be typical of the degree of agreement which may be found between determinations made with different sized tubes. Sometimes exact agreement is observed; more often slight persistent discrepancies appear.

The curves for the slip of medium consistency flowing through the different tubes when plotted according to the simpler method recommended for practical use, *i.e.*, as average rate of flow against average height, appear as shown in Fig. 5. The 0.4114 by 15.73 cm. tube seems on the whole best adapted to give satisfactory results over a fairly wide range of consistencies approximating those likely to be encountered in dealing with casting slips and has therefore been selected as best for use in making all tests.

Application of Plasticity Measurements

Determining the plasticity of a casting slip or of any other slip in pottery practice is suggested as a means of master control and as a means of guiding experimental work dealing with proposed changes in the slip. It may be found, for instance, that when a certain clay or shipment of clay is substituted for a clay from a supply previously used, the slip does not have the same characteristics; upon determining its plastic flowing quality it may be found that although the yield value and stiffness are the same the starting pressure is greater. This condition would probably lead to balling in the cast ware. It will be necessary to add some salt in sufficient amount and perhaps also to change water content by a few tenths of a per cent in order to bring the slip back to the same plastic flowing condition and thereby to the same casting condition. In attempting to attain the most desirable casting condition it is preferable to keep the slip as free as possible from soluble materials. Thus it may often be found preferable to change the nature of the deflocculant or deflocculants added rather than attempt to make the slip work satisfactorily by greatly increasing the amount of any given chemical substance (as sodium carbonate or sodium silicate) in order to minimize effects associated with scumming.

In order that a plant superintendent may be in a position to make the proper adjustment immediately when his slip does not act in the usual satisfactory manner he should have at hand the results of preliminary work with his particular slip showing the way in which its plasticity is varied by small additions of various salts and by slight changes in water content. For ordinary batch testing of the slip where no known changes are being made it should suffice merely to determine in a

routine way specific gravity and flowing time as obtained upon such an apparatus as has been described by Bleininger and Hornung.[12] This method involves the timing of the flow through an orifice, a process which may be simply and quickly carried out. In probably all cases these tests will detect whether or not the slip is remaining the same from day to day and hence whether or not it is desirable to make a plasticity determination in order to get a clearer picture of the kind of correction that may need to be applied. In using the apparatus of Bleininger and Hornung it is unnecessary to use the top with its attached air inlet tube (which is proposed for the purpose of maintaining a constant head during the time of flow), the chief consideration being that the same procedure be used for every determination. Thus it is quite satisfactory to fill the 2- by 6-inch brass cylinder up to the top while holding the finger over the $^{5}/_{32}$- by $^{5}/_{32}$-inch orifice, place the apparatus above a 250 cc. graduated cylinder, remove the finger allowing the flow to start, start the stop-watch as the level of the slip in the cylinder passes the 50 cc. mark, and stop it as this level passes the 250 cc. mark. If results are to be duplicated, it is of primary importance that the orifice be clean and dry before the slip is placed in the container.

It is desirable in all research laboratory work that the experimental batches be subjected to temperatures and times of stirring corresponding to plant conditions if the same results are to be expected when the same batch is used in the plant. Standing for a short time may be expected to increase the stiffness of a slip since most slips tend to gel or "set up" upon standing, although as a rule a short time of standing does not alter yield value or starting pressure to any considerable extent. Standing for a long time such as two or three days may alter starting pressure and yield value as well as stiffness, the nature and amount of the change depending upon the kind of chemical and physical action taking place between the particular deflocculating salts and the clays and other solid materials used and the kind and amount of soluble substances adsorbed by these fine solid particles before the slip was made from them. It is possible for a number of complicated reactions to occur in any slip on account of the number of substances which are present and the physical nature of the solid materials which offer a large total surface where adsorptive effects may take place.

It may be in order to mention the fact that of course no amount of correctness of the slip can be expected to overcome troubles due to other sources such as improper mold design. If, for instance, in the solid- or core-casting process the pouring funnel does not empty directly into

[12] A. V. Bleininger and M. R. Hornung, "Notes on Casting," *Trans. Amer. Ceram. Soc.*, **17**, 330 (1915).

the largest cross-section to be cast up and no provision is made to prevent choking off of the slip flow at the narrower cross-sections as water drains off into the mold, an unsound casting may logically be expected.

For the successful casting of vitreous sanitary ware from the point of view of this work the general object is to obtain a slip having a flowing quality represented by a curve similar to the one marked "regular" in Fig. 5. Stated in numerical terms which are dependent upon the size of flow tube used on the consistometer described this requisite plasticity may be said to be a stiffness of 50 to 70 cm. per cc. per sec., yield value of 15 to 25 cm., starting pressure of 5 to 12 cm., and plasticity ratio of 3.0 to 2.5. If more ability to stretch out without cracking when in the wet cast condition is wanted, make such changes that will produce a higher plasticity ratio and yield value. A high yield value and plasticity ratio of the slip are the concomitants of good working quality of the plastic body as determined by the ordinary method of noting its feel to the hand. If casting a simple straight-walled piece and solidity of cast is especially desired, make such changes that will produce a slip of low yield value and high plasticity ratio, remaining of course preferably within the above-named limits. The slip is regulated according to the kind of piece to be cast or if a number of different shapes must be made from the same slip it is regulated to the mean of the two most desirable conditions for the extremes in the kinds of pieces being made. The gravity flow tube consistometer appears to be a suitable measuring instrument for accomplishing this and similar regulation where degree of plasticity in the slip state is a considerable if not all important item in gaging the correct working condition.

CHEMICAL CONTROL OF FELDSPARS[1]

By F. P. Knight, Jr.

ABSTRACT

A definition of feldspar is given. Minerals in feldspars are enumerated. The importance of chemical control, method of analysis, and calculation of mineral composition from chemical analysis are taken up. A discussion of the value of the calculation is presented. In explaining mechanical control procedures, method of sampling, storage and mixing of feldspars, fusion test, block test, reasons for the non-uniformity in fusions and free quartz determinations are described and discussed.

Introduction

There is a need for the consumer of feldspar to have better understanding of the nature and source of that commodity. The view-point presented here is that of a feldspar producer, and the subject matter presents knowledge and ideas acquired during feldspar production under chemical control since 1923. During this time approximately 2000 complete analyses of widely varying feldspars have been made. This year another 1000 will be added to the list. The attendant expense would not be incurred were it believed to be unjustified, and it is sincerely hoped that it will bring an increasing yield to the consumers, and to this company, as understanding of the value as well as the limitations of the analyses increases.

What is Feldspar Feldspar is a general term applied to a group of minerals, all aluminum silicates with potassium, sodium, calcium, or barium; whereas commercial feldspar, so called, is a term applied to a product mainly composed of feldspars, but also containing accessory minerals, chief of which are quartz and the much less abundant muscovite mica.

Although feldspars form nearly 60% of the igneous rocks, the commercial product is obtained from the comparatively rare pegmatites, which are greatly magnified granites wherein the crystals of feldspar and quartz, instead of being barely distinguishable with the naked eye, may be several feet in cross-section. The coarseness of crystallization together with the care taken in selection while mining pegmatites largely determines the purity of the commercial feldspar.

Separation of quartz can only be practically made where crystals are comparatively large, and the amount of quartz separated under such conditions, depends entirely upon the care used in selection. The finer crystallization, called graphic granite, or "corduroy," contains 20 to 30% quartz and must be marketed with this quartz content. It is fortunate that these graphic granites, and other feldspars of

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (White Wares Division.)

relatively high free quartz content, find favor with many users, when comparatively free from other impurities, because, were the demand solely for feldspar free from quartz, resources would soon be exhausted. Prices would also be much higher, because practically all of a pegmatite must be mined and sorted in order to get the pure feldspar. Iron-bearing minerals must of course be removed by careful sorting.

The pegmatites, as stated, are composed of feldspar, quartz, muscovite mica, and iron-bearing minerals. It must be remembered, however, that feldspars are subject to alteration, and may be partially, semi-, or wholly kaolinized. Pegmatites may be vegetable-stained near the surface or solutions carrying iron may penetrate them and cause the darker iron stain. They may be peppered throughout with iron-bearing minerals or portions may be comparatively free from such impurity. Pegmatites are of infinite varieties, and in addition to the above features, every one of them contains at least three different feldspars.

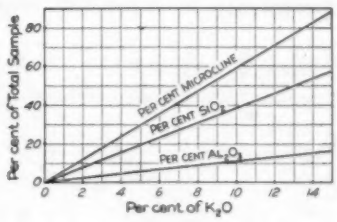

FIG. 1.—Microcline: $K_2O \cdot Al_2O_3 \cdot 6SiO_2$. $SiO_2$64.81%; $Al_2O_3$18.31%; K_2O16.88%

Minerals in Feldspars This variation in pegmatites will be further evidenced by the following discussion of the actual minerals involved.

Microcline or potash feldspar is the most abundant pegmatite mineral. It has the same chemical composition as the rare orthoclase. The molecular formula for both is $K_2O \cdot Al_2O_3 \cdot 6SiO_2$.

Albite or soda feldspar has the molecular formula $Na_2O \cdot Al_2O_3 \cdot 6SiO_2$, and is next to microcline in importance.

Anorthite or lime feldspar has the molecular formula $CaO \cdot Al_2O_3 \cdot 2SiO_2$.

Celsian or barium feldspar is infrequently found in extremely small quantities in pegmatites. It will henceforth be disregarded.

The three important basic feldspar minerals given above are never found separately as pure crystal aggregates in any pegmatites. Soda is always present in the most carefully selected pieces of potash feldspar, and the writer has never found lime wholly absent. The soda may have replaced part of the potassium to form soda-microcline, or the soda feldspar (albite) may be interlaminated with or interspersed among microcline. We believe this interlamination to be far more common than replacement. It is frequently found that when a crystal of microcline is fired to a temperature between the softening point of albite and microcline, the albite laminations or plates are plainly

distinguishable with a glassy appearance amid opaque microcline. Another reason against replacement as the chief cause of soda in microcline is the ever present lime which would be introduced by the interlaminated albite.

As soda is always found in so-called microcline, so is potash present in so-called albite although to a less extent.

Albite and anorthite require simultaneous consideration. They form the series of plagioclase feldspars, with *n* albite *m* anorthite. It is generally considered a series of isomorphous mixtures,[2] of which oligoclase is the only one which need be mentioned here. It has an albite-anorthite ratio varying from 6:1 to 3:1.

In addition to the intimate association of these minerals in selected specimens, it must be remembered that the predominating large crystals of soda-bearing microcline are not far removed from the less abundant crystals of plagioclase feldspars. This latter association is most important, for the irregular occurrence requires most careful mining and handling in order to prevent non-uniformity in shipments.

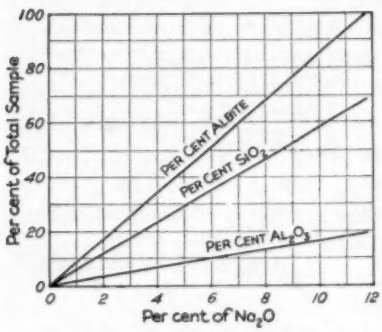

FIG. 2.—Albite: $Na_2O \cdot Al_2O_3 \cdot 6SiO_2$. SiO_2 68.78%; Al_2O_3 19.43%; Na_2O 11.79%

It will be understood from the above discussion that a varied ratio of potash to soda to lime feldspars may be produced even from one pegmatite, and that high potash, high soda, and high lime represent three extremes, of which high potash is the most abundant.

The next important pegmatite mineral is quartz, which occurs as practically pure SiO_2. The essential thing is to keep its content as constant as possible in shipments of feldspar to individual consumers. Because its occurrence in the pegmatites is extremely irregular, this is a very difficult requirement to meet satisfactorily, especially without chemical control. The average quartz content of the feldspar consumed today is probably a little over 15%.

The most important minor mineral of the pegmatites is muscovite mica, commonly called "white mica." Much of it is concentrated in separate areas and is carefully kept by itself. The predominating thick slabs are valuable and are carefully mined. Some deposits, however, have small flakes or perhaps the thicker "books" scattered through them. These require careful attention.

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[2] F. W. Clark, "The Data of Geochemistry," U. S. Geol. Surv., *Bull.*, No. 770, p. 367.

The following iron-bearing minerals may be present in pegmatites, but fortunately in small amounts because of their effect upon color.

Garnet is a common impurity and a very small amount seriously affects the fired color of the feldspar. Some deposits are peppered with it and therefore are of little value. Fortunately, in others it is generally segregated in the ground to an extent that permits the removal of all but an extremely small percentage.

Biotite (black) mica is practically absent from many pegmatites. Where present it is generally abundant, and extremely difficult to separate, although it is frequently concentrated in separate areas of a pegmatite and relatively absent from the remainder.

Black tourmaline is seldom encountered in some sections of the country but is frequent in others. Wherever present it must be carefully removed.

Magnetite (Fe_3O_4) and pyrite (FeS_2) may be present in very small amounts. They show as specks in fired ware and deposits showing an appreciable amount of either are of decidedly inferior value, magnetite being especially difficult to remove because of its fine dissemination.

In addition to the above minerals, small quantities of iron from process machinery are found in commercial feldspars when ground.

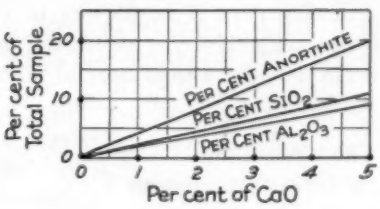

FIG. 3.—Anorthite: $CaO \cdot Al_2O_3 \cdot 2SiO_2$ SiO_2 43.26%; Al_2O_3 36.66%; CaO 20.08%

Iron is also included in the mineral feldspars themselves, the red microcline frequently carrying 1.0% Fe_2O_3. The distinctly green variety of microcline carries the highest percentage of any, but is rare.

There are many rarer pegmatite minerals of minor importance. The phosphates, amblygonite and apatite, where present in appreciable amounts, should be carefully watched by the feldspar producers. This applies to all rare minerals, for there is good possibility that their effect is out of proportion to their quantity.

Importance of Chemical Control

Control of the extreme variations possible in the product of a single pegmatite is the chief problem of the feldspar producer. After due investigation, it was decided that chemical control was feasible and profitable. In the beginning, the major drawback seemed to be the difficulty of attaining accuracy in the analyses. It was said that widely varying results were being reported from different laboratories upon the same samples of feldspar. Such condition still exists, but to a far

less degree, owing to the Bureau of Standards' "Standard Sample No. 70, Feldspar."

Method of Analysis It was realized that accuracy was essential to the successful exercise of chemical control and various methods of analysis were tried. The method advocated by W. F. Hillebrand[3] was found to be the simplest and most accurate and was adopted. The method includes the following steps:

> Decomposition of the sample from which all constitutents except potassium, sodium, and iron are to be determined is made with sodium carbonate in platinum crucible. Double evaporation with hydrochloric acid is made for separation of silica. The second dehydration is finished after an hour at 120°C. Correction for impurities in the silica residues is determined in all cases. Double precipitation of alumina, iron, etc. is made, and the small amount usually washed into the second filtrate re-precipitated, and filtered. Calcium and magnesium are given single precipitation and allowed to set over night. Iron is determined volumetrically from a 5-gram sample decomposed with hydrofluoric and sulphuric acids. Potassium and sodium are determined by the J. Lawrence Smith method, potassium being determined as perchlorate. Blank determinations are made with all new reagents, to determine the ever necessary corrections.

Every care is employed to insure accuracy of samples, something often neglected, yet absolutely essential; and a high degree of accuracy, especially for a commercial laboratory, is maintained in the analytical work.

Calculation of Mineral Composition Given an analysis, the next procedure is to consider the mineral composition it represents. Calculation of this composition frequently shows up glaring errors in analysis. More important, it yields a basis for the feldspar producer to work upon, and this same basis is one which will become of great value to the feldspar consumer. It has its limitations, but its advantages greatly outweigh them.

This relation of mineral composition to analysis of feldspar usually need not involve consideration of more than four theoretical minerals: microcline, albite, anorthite, and quartz. In this case all K_2O of the analysis is assumed to belong to microcline, all Na_2O to albite, and all CaO to anorthite. Theoretically, microcline contains 16.88% K_2O. Therefore, a sample containing 50% microcline would have a K_2O content of 8.44%, provided there were no other source of K_2O in the sample. Conversely, if a sample shows a K_2O content of 8.44% it contains 50% microcline, provided all the K_2O belongs to that mineral. Thus it follows that with the above assumption that all K_2O belongs to microcline any K_2O value in the analysis divided by 0.1688 will give the per cent of the total sample that is microcline. The same argument, with different values, applies to both albite and anorthite. To facilitate matters, these relations are plotted in Figs. 1, 2, and 3.

[3] "The Analysis of Silicate and Carbonate Rocks," U. S. Geol. Surv., *Bull.*, No. 700.

Take for example the following analysis:

	Per cent
SiO_2	70.86
Al_2O_3	16.20
Fe_2O_3	0.13
CaO	0.81
MgO	0.04
K_2O	8.27
Na_2O	3.32
Loss on ignition	0.39
	100.02

Turning to Figs. 1, 2, and 3, values of 49% microcline, 28.2% albite, and 4.0% anorthite are read for 8.27 K_2O, 3.32 Na_2O, and 0.81 CaO, respectively. Pure microcline contains 64.61% SiO_2. Therefore, if the microcline content of a sample is multiplied by .6481, the result is the per cent of the total sample which is SiO_2 contained in the microcline. Similar argument applies to alumina and to the silica and alumina of albite and anorthite, different figures, of course, applying with the last two. These silica and alumina values are plotted with the alkali-mineral relations, and from Fig. 1 are read values of 31.9 SiO_2 and 9.0 Al_2O_3 for 8.27% potash or for 49% microcline. Tabulated readings from these graphs give the following figures for the above analysis:

	Per cent of Sample	SiO_2	Al_2O_3
Microcline	49.0	31.9	9.0
Albite	28.2	19.5	5.6
Anorthite	4.0	1.8	1.4
	81.2	53.2	16.0

The figure of 53.2% SiO_2 is the percentage of the total sample which represents the silica belonging to the feldspar minerals. The difference of 17.66% between the total silica content of 70.86 and the 53.2% belonging to the feldspars, may be considered as being derived from quartz. This is not strictly accurate, for the impurities are silicates and some of the silica belongs to them. It is commonly done, however, and except in cases where the minor minerals are present in unusual amounts, assigning the remainder of the silica to quartz is permissible. By so doing the following mineral composition of the sample under discussion is obtained:

Microcline	49
Albite	28.2
Anorthite	4.0
Quartz	17.7
Other	1.1
	100.0

An analysis similar to the above, with mineral composition similarly calculated, is given on the following page.

	Per cent			SiO_2	Al_2O_3
SiO_2	70.27				
Al_2O_3	17.29	Microcline	48.2	31.3	9.0
Fe_2O_3	0.14	Albite	28.8	19.9	5.6
CaO	0.69	Anorthite	3.3	1.5	1.2
MgO	Trace	Quartz	17.6		
K_2O	8.13	Other	2.1	52.7	15.8
Na_2O	3.38				
Loss on ignition	0.21				
	100.11				

The two samples above show calculated mineral compositions that are almost identical. The important thing to notice is that there is considerable excess Al_2O_3 in the second sample beyond that necessary for the feldspar minerals. This is often an indication of a poor analysis and one in which the silica has received but a single evaporation and dehydration. Yet this is not necessarily true, for were this second sample to contain a relatively high percentage of muscovite, and the frequent slight amount of kaolinite, the alumina would be accounted for. If muscovite is present in the second sample, a little K_2O belongs to it. But as adjustment for muscovite can only be reasonably made when data from microscopic examination, specific gravity, or other tests are available, in the absence of such data, it is better to disregard it in the calculations.

Consider next a sample of partially kaolinized feldspar of the following analysis:

	Per cent			SiO_2	Al_2O_3
SiO_2	65.58				
Al_2O_3	19.40	Microcline	74.2	48.1	13.7
Fe_2O_3	0.11	Albite	9.4	6.5	1.9
CaO	0.40	Anorthite	2.0	.9	.7
MgO	0.05	Quartz	10.1		
K_2O	12.54	Other	2.3	55.5	16.3
Na_2O	1.20				
Loss on ignition	0.89				
	100.17				

Here the inaccuracy of the simple calculation is too great to let pass. There is 3.1% Al_2O_3 unaccounted for, and excess H_2O which, with the alumina, indicates kaolinite, commonly called kaolin. This has the formula $H_4Al_2Si_2O_9$, and contains by weight 46.60% silica, 39.49% alumina, and 13.91% H_2O. Assume that, of the 3.1% excess alumina above, 2.5% is due to kaolin. This would mean $2.5/39.49 = 6.33\%$ kaolin, which would require 0.88% H_2O, and 2.95% SiO_2. With this assumption, the resultant calculated mineral content would be:

	Per cent
Microcline	74.2
Albite	9.4
Anorthite	2.0
Quartz	7.1
Kaolinite	6.3
Other	1.0

Value of the Calculations Because of the obvious approximations of the above calculations of mineral compositions, question is likely to arise as to their value. The answer is that any such calculations, however refined, must by their very nature be approximations, and the question becomes therefore whether or not the approximations fall within limits which are sufficiently accurate for practical purposes. It is believed that they are and that the information which they yield is basic and of high potential as well as actual value. Commercial feldspar contains basic minerals. Feldspar investigations of highest value deal with these basic minerals. A Bureau of Mines *Bulletin*, by A. S. Watts contains the most valuable thesis on feldspar that has been written.[4] This is largely because of the data presented regarding the properties and relations of the purest feldspar minerals available for the investigation. There is need of more such work. There is also need of general knowledge of the things outlined in this article in order that full value may be obtained from the results of such research.

A specific instance of the lack of knowledge of the existence, and application of such a thesis as Watts', is of a consumer who insisted upon receiving feldspar carrying at least 10% potash (K_2O) and not over 3.0% Na_2O. It was supplied, and he complained of "hardness," at the same time requesting that the soda be lowered to give increased fusibility. Explanations that lowering the soda would give exactly the opposite effect from that which he desired, were ineffective; he demanded and received material as specified. No further specifications or orders were ever received. Had this consumer been familiar with the results of Watts' investigations, he would not have made such specifications.

Were the mineral composition of feldspar and its relation to analyses understood, consumers would be in a better position to give specifications, to check up on their source of supply, and to use the feldspar with far better results.

The producer of feldspar must furnish satisfactory material to the industry. Few requirements are alike, and manufacturers of the same lines of ware use widely differing materials. Uniformity is the one universal requirement. Therefore, the first problem of the feldspar producer is to find out what is wanted and to submit samples of satisfactory quality. This is by no means a simple proposition in most cases, and to find out the maximum allowable variation from the satisfactory sample is rarely possible. Thus, the second problem of the

[4] A. S. Watts, "The Feldspars of the New England and North Appalachian States," Bur. of Mines, *Bull.*, No. 92.

feldspar producer, and the most difficult of solution, is that of maintenance of uniformity, a term used only in a relative sense, because no feldspar can be supplied in absolutely uniform shipments.

Mechanical Control Procedures

Variations in shipments are inevitable, and while striving to hold these variations within as narrow limits as possible, it was concluded that a method of accurately sampling and testing feldspars before grinding was essential to success. The sampling of crude material offered a considerable problem. A method similar to that used by smelters when purchasing precious ores was necessary in spite of the expense.

Sampling The method of operation used is to crush to minus $^3/_4$ inch the particular crude material, contained in a separate crude storage bin, and which is to be used in the mixing bins. The crusher product is conveyed to the sampling unit which cuts out a sample as accurately as is done in many custom smelters handling gold ores. The "reject" from the sampling unit passes to one of twenty intermediate storage bins, called mixing bins, each of 80 tons capacity. The sample is taken to the laboratory, ground in a small pebble mill, and carefully split to give smaller samples for fusion tests and analysis. Results of these tests are available before the feldspar is drawn from the mixing bin containing the sampler reject. From these tests, together with observation of the crude material, the mineral content of that bin of feldspar is known to a high degree of accuracy.

Storage and Mixing of Feldspars There is kept on hand in these 20 mixing bins, analyzed material of varying qualities and types. From this range of feldspars the material is drawn which will meet the requirement for the particular shipment to be ground. The range available permits practically any specification to be met, and to duplicate past shipments far more closely than is possible otherwise. The method is not infallible, but is a decided improvement. Analyses of the car shipments themselves are checks upon the working of the mixing bins, and from them we have learned that the above method of control yields results surpassing our early expectations.

Fusion Test

It will have been noted that the valuable fusion test is not disregarded. It is the final test for color and although it is rare that the fused result can not be foretold from the analysis, the fusion is a check upon the analysis, and its appearance often indicates the presence of some minor minerals as well as kaolinite. A peculiar instance of this is the fact that some northern feldspars yield a porous structure when fused, especially if the rate of firing is high. The analyses do not show definite reason for this and the matter is now being investigated.

Block Test

This porosity seems to have a decided effect with the recently devised block test. A sample of northern feldspar was fused beside one of the North Carolina feldspars having similar analysis. Both were in blocks. Our sample appeared to be the softer, in spite of its considerably higher lime content, which indicated a different result. In order to check the block test, cones of standard dimensions were then made from each feldspar and fired side by side. The cone of the northern feldspar was down before the other had more than turned, results in contradiction of the block test. With the porosity of the northern feldspar shrinkage was slight and the material held back in the block, whereas the normal shrinkage of our sample allowed it to flow through, and thus appear to be the softer. Another factor of importance in this connection is the coarseness of grinding, which has an exaggerated effect due to the mechanics of the block test.

Fusion Tests Lack Uniformity

Those who rely wholly upon fusion tests of feldspar are perhaps more dependent upon the feldspar producer than they realize. There are several possible combinations in feldspars, which will yield the same fused appearance. As an illustration, we have examined samples of oligoclase feldspar, having an albite-anorthite ratio of very nearly 3 to 1, and with an extremely low K_2O content, which at cone 8 were sintered to about the same extent as a feldspar of 80% SiO_2. The oligoclase had a silica content of about 63% and a free quartz content of less than 5% as against approximately 40% of the feldspar containing 80% silica. A more practical illustration is that of a consumer who may be using feldspar of 70% SiO_2. His next shipment may contain 75% silica and its appearance after firing may be identical with the 70% SiO_2 feldspar. This approximately 15% higher free quartz content of the 75% SiO_2 feldspar may be detected by making fired trials with added quartz, but this is not always done. The fact that such cases are actual and that this variation is absorbed shows the ability of the operators and indicates the wide range of material which can be used. Such variation, however, is not necessary and must be harmful. Fortunately it is the exception rather than the rule.

Free Quartz Determination

Much has been written about free quartz in feldspar. More has been published about the determination of its percentage than about its effect in ceramic processes, which is logical. We have tried many ways of determining this free quartz content, and, when dealing with fine powder, have found no method which has warranted its adoption,

except a chemical analysis. Given an analysis, there is no correct method of calculating free quartz content which does not take into consideration the minerals associated with the quartz.

Conclusion

Chemical control is an established procedure in feldspar production. It is not infallible, and offers much room for research and improvement but it has unquestionable value, and ultimate possibilities that are significant.

The term "feldspar," as applied to the commercial product, covers a wide range of mineral composition.

A chemical analysis of a correct sample is an indicator of the mineral content of the particular lot represented by that sample. It not only will enable the consumer to order what he wants, but to see that he gets it. By keeping record of the analysis and mineral composition of each shipment he receives, together with the results obtained with it, he not only will accumulate data which will enable him to make adjustments simply and quickly to care for variations, but in many cases he will find indications that a change in composition would be desirable.

The chemical analysis alone is a decided help but the calculated mineral composition provides a check upon the analysis, permits of adjustment to take care of free quartz content, and above all, gives the actual ingredients of the material called commercial feldspar; mineral ingredients, each of whose action has a distinct bearing upon the quality of the finished ware.

Whether or not the user of feldspar profits directly through use of analyses and their mineral relations, he does so indirectly, because of their great value in the production of that commodity.

TENN. MINERAL PRODUCTS CO.
SPRUCE PINE, N. C.

ADSORPTION AT CRYSTAL-SOLUTION INTERFACES*

III. Individual Macroscopic Ammonium Alum Crystals Grown in the Presence of Gelatin and Dyes

By G. W. Bennett and W. G. France

ABSTRACT

The present work is a continuation of the study of adsorption processes at solution crystal interfaces. It consists of an investigation of the adsorption of dyes, gelatin, and amino acids by the various faces of ammonium alum. The growth ratios of this alum were measured both in the presence and absence of these foreign substances. Adsorption was found to occur only at the cube faces and to be specific in character. The effects obtained are explained on the basis of residual valencies, polar groups in the adsorbed material, and the interionic distances in the crystal lattice. The extension of these ideas to the study of the flocculation of suspensoid sols has been suggested. The growth ratio V_{100}/V_{111} for pure ammonium alum was found to be 1.53.

Introduction

In previous articles the growth[1] and solution of single copper sulphate crystals, and of potassium alum crystals[2] in the presence of gelatin and dyes was studied. It was found that these substances modified the velocity of perpendicular displacement of the crystal faces, and also modified the crystal habit. These effects were attributed to the specific adsorption of these substances at the crystal solution interface. The present investigation was undertaken to obtain further information concerning the mechanism of such adsorption processes. It is a continuation of the study of selective adsorption by crystal faces, using ammonium alum crystals. Ammonium alum was used because its crystal structure has been studied,[3] and because it is comparable to that of potassium alum.

An exhaustive review of the literature relating to the use of dyes in crystal study may be summarized briefly. In an effort to produce artificial dichroism Senarmont[4] found that $Sr(NO_3)_2 \cdot 5H_2O$ crystals were colored by logwood, saffranine, and tumeric. Gaubert[5] colored liquid crystals, and Lehman[6] the so-called flowing crystals, when such crystals were grown in solutions containing dyes.

Reinders[7] showed that the effect of the dye is specific; one dye may color several kinds of crystals and be without effect on others, or as

* Received March 1, 1928.

[1] T. S. Eckert and W. G. France, *Jour. Amer. Ceram. Soc.*, **10** [8], 579 (1927).

[2] F. G. Keenen and W. G. France, *Ibid.*, **10** [10], 821 (1927).

[3] Vegard and Schjelderup, *Ann. Physik*, [4], **54**, 146 (1917).

[4] *Ann. chim. phys.*, [3], **41**, 319 (1854); *Compt. rend.*, **38**, 101 (1854); and *Pogg*, **91**, 491 (1854).

[5] *Compt. rend.*, **167**, 368 (1918).

[6] *Ann. Physik*, [4] **8**, 908 (1902).

[7] *Z. physik. chem.*, **77**, 212 and 677 (1911).

Eckert and France[8] found one dye may color one kind of crystal and be without effect on a closely related salt. Lehman[9] cited cases where a mixture of several dyes, neither of which alone was capable of coloring crystals was able to do so when mixed. On the other hand Gaubert[10] found that isomorphous mixtures of inorganic crystals were more strongly colored by a given dye, than each pure component was colored by that dye.

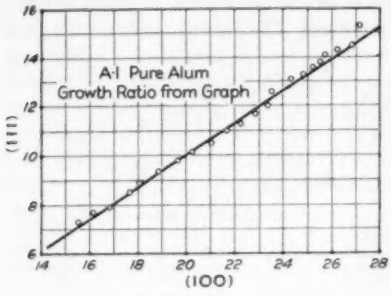

FIG. 1.

Gaubert[11] distinguished two distinct and fundamentally different types of coloration of crystals. The first type is accompanied by profound changes in physical properties of the crystals. Thus Keenen and France[12] found the growth of faces was repressed; Retgers[13] and Marc and Wenk[14] reported the crystal habit was sometimes strongly modified; Ambronn[15] found that dichroism was produced in the crystal; and Wenk[16] and Marc[17] reported that the crystallization velocity was greatly repressed. On the other hand, Gaubert[18] found there was no change in the crystal angles, the density, melting point, or in the solution velocity of the crystals.

The second type of coloration according to the researches of Lehman,[19] Becquerel,[20] and Gaubert,[21] produces no such remarkable changes in the physical properties of the crystals although the crystals are uniformly and distinctly colored.

It is to be noted that sometimes the dye is not taken up uniformly, but is much more strongly adsorbed by certain faces. This unequal adsorption gives rise to the "hour glass" patterns reported by

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[8] *Jour. Amer. Ceram. Soc., loc. cit.*

[9] *Z. physik. Chem.*, **8,** 543 (1891); *Z. Krist.*, **22,** 609 (1894); *Wied.*, **51,** 47 (1894); and *Z. Krist.*, **27,** 438 (1897).

[10] *Bull. Soc. franc. Mineral.*, **23,** 211 (1900).

[11] *Compt. rend.*, **151,** 1134 (1910).

[12] *Jour. Amer. Ceram. Soc., loc. cit.*

[13] *Z. physik. Chem.*, **12,** 600 (1893); *Z. Krist.*, **25,** 512 (1896).

[14] *Z. physik. Chem.*, **68,** 104 (1910).

[15] *Ber. deut. botan. Ges.*, **7,** 113 (1889).

[16] *Z. Krist.*, **47,** 148 (1910).

[17] *Z. physik. Chem.*, **73,** 685 (1910); *ibid.*, **79,** 71 (1912).

[18] *Bull. soc., franc. Mineral.*, **28,** 286 (1905); *Compt. rend.*, **142,** 219 (1906).

[19] *Z. Krist.*, **12,** 391 (1887).

[20] *Ann. chim. phys.*, [6], **14,** 249 (1888).

[21] *Bull. soc. franc. Mineral.*, **25,** 242 (1902).

Seherr-Thoss,[22] Lehman,[23] Maschke and Vater,[24] and Pellikan.[25] Inclusions may be detected under the microscope in certain cases, but in others the crystals are homogeneously colored. Reinders[26] and Marc[27] have measured the quantity of dye in a crystal. The results indicate that this quantity for some dyes is independent of the crystallization velocity, and for other dyes the quantity is independent of the concentration of the dye in the solution.

Other miscellaneous experiments have been made, but apparently only Eckert and France (*loc. cit.*) and Keenen and France (*loc. cit.*) have studied from a quantitative view point, the growth of individual macroscopic crystals in solutions containing dyes.

TABLE I

EFFECT OF FOREIGN SUBSTANCES ON CRYSTAL HABIT

Bismarck brown	No effect	Congo red	Insoluble in alum solution
Methylene blue	" "	Immedial green	" " " "
Napthol yellow	" "	Thiocarbone	" " " "
Brilliant green	" "	Diamine sky blue FF	Repressed cube faces
Ponceau red 2R	" "	Oxamine blue B	" " "
Quinoline yellow	" "	Anthraquinone green	" " "
Fuchsine	" "	Crystal violet	Colored crystal throughout without affecting growth ratio
Flavazine	" "		
Methyl violet	" "		
Victoria scarlet	" "	Gelatin	No effect
Pararosaniline base	" "	Agar-agar	" "
Saffranine	" "	Asparagine	" "
		Phenylaminoacetic acid	" "
		5% Formalin	" "

Apparatus

A 6- by 6- by 3-foot air thermostat housed a thermal regulating unit, cooling coil, and fan beneath a table. On the table was an illuminating lamp, crystallization cell, and lens system, leading to a spring-driven motion picture camera. A specially constructed clock which has been described[28] automatically controlled the camera, so that exposures were made every half hour over periods of from 20 to 30 hours during which time the crystal was allowed to grow.

Experimental

(A) Qualitative Ammonium alum crystals were grown in solutions containing dyes, and of some 22 dyes, gelatin, and amino acids, three dyes showed effects on the physical properties of

[22] *Wied.*, **6**, 284 (1879).

[23] *Z. physik. chem., loc. cit.*, Vol. 8.

[24] *Z. Krist.*, **33**, 57 (1900).

[25] *Tschermak's mineral. petrog Mitt.*, **13**, 258 (1892).

[26] *Z. physik Chem.*, **77**, 677 (1911).

[27] *Ibid.*, **75**, 710 (1911).

[28] F. G. Keenen, G. W. Bennett, and W. G. France, *Jour. Amer. Ceram. Soc.*, **10**, [6], 435 (1927).

the crystals. These three, together with another dye, the amino acids, and gelatin were chosen for study from a quantitative view point.

Only two of the miscellaneous qualitative experiments need be described. In the first, crystals of potassium alum colored with diamine sky blue were recrystallized from hot water. The crystals which resulted contained the dye in a very striking double hour-glass pattern as a blue Maltese cross in a white field. In the second experiment potassium alum crystals were suspended in saturated solutions of potassium alum containing dyes. The bottles which were stoppered to prevent evaporation were kept in a thermostat. After two weeks' time no adsorption of the dye had taken place.

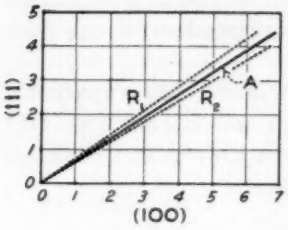

FIG. 2*a*.—Pure alum and other experiments in which there was no change in habit.

A 1.53, average ratio
R_1R_2 1.43–1.66, range

(B) Quantitative All the quantitative experiments were performed in the air thermostat at 30.0±0.1°C. The crystallization cell was filled ammonium alum solutions saturated at 30°, to which weighed amounts of the desired foreign materials were added. A crystal of ammonium alum taken from carefully selected seed crystals, was fastened to a platinum wire by plunging the heated end of the wire into the crystal. The small crystal could then be carefully oriented so as to bring the desired faces into view, and was thus held rigidly in place.

TABLE II

GROWTH RATIO DATA FOR PURE ALUM

Series A-1; Pure alum crystal—slightly turbid
Temperature 29.60° ± 0.08°

100	111	100	111
15.5 cm.	7.3 cm.	22.8 cm.	11.7 cm.
16.1	7.7	23.3	12.0
16.8	7.9	23.5	12.7
17.6	8.5	24.3	13.1
18.0	8.9	24.8	13.3
18.8	9.3	25.2	13.6
19.6	9.8	25.4	13.8
20.2	10.1	25.7	14.1
21.0	10.5	26.2	14.3
21.6	11.0	26.8	14.5
22.2	11.3	27.1	15.3

Growth determined from graph, (100) = 12.1 cm. (111) = 8.0 cm.
Ratio (100)/(111) = 1.51

An initial exposure of the film was made immediately, and after that at every half hour by the automatic device, over periods of from 20 to 30 hours. At the end of this time the film was developed and dried. The image was projected on a white screen with about a 25-fold magnification, and the distances between cube faces and between octahedral faces were measured with a meter stick.

The ratio between the corresponding perpendicular displacements of the cube and of the octahedral faces, varies with the extent of adsorption, because as will be shown, when adsorption takes place, the perpendicular displacement of the cube faces is repressed.

TABLE III

p_H VALUES

Alum solution containing	E. Obs.	p_H	Alum solution containing	E. Obs.	p_H
Pure alum solution	0.280	2.94	Crystal violet	0.280	2.94
" " "	0.280	2.94	Bismarck brown	0.280	2.94
" " "	0.280	2.94	Asparagine	0.283	2.89
Anthraquinone green	0.280	2.94	Phenylaminoacetic acid	0.280	2.94
" "	0.2795	2.94	Gelatin	0.280	2.94
Oxamine blue	0.280	2.94	Formalin	0.286	2.82
Diamine sky blue	0.280	2.94			

A considerable error in the measurement of the projected images may be made owing to the lack of sharpness of the edge of the image. Successive displacements are then subject to considerable error, and even the average displacement may have a noticeable error. This difficulty was largely overcome by the following expedient. The numerical values of the distances between cube faces are plotted on coördinate paper against the corresponding values for the octahedral faces. The slope of the line drawn through these points then gives the desired ratio. By this scheme ratios are concordant among themselves to 5% or less, while ratios obtained in other ways vary as much as 15%. Ratios obtained by the earlier investigators varied as much as 100% from each other.

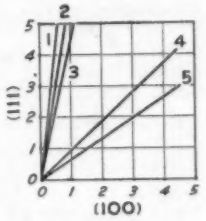

FIG. 2*b*.—Diamine sky blue FF.

No.	Expt.	Ratio
1	C–4	0.129
2	C–3	0.187
3	C–5	0.238
4	C–2	1.09
5	C–1	1.56

Dye Concentration
0.01 g./100 cc.
0.005
0.00375
0.0025
0.00125

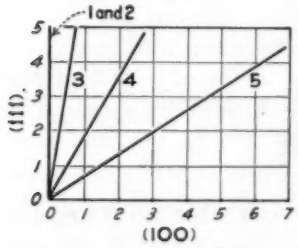

FIG. 2*c*.—Oxamine blue.

No.	Expt.	Ratio	Dye Concentration
1	D–3	0.00	0.0025g.
2	D–2	0.00	0.00125
3	D–4	0.145	0.00084
4	D–5	0.550	0.00042
5		1.53	0.00

The hydrogen-ion concentration in the solutions used, as determined by the ordinary potentiometer method and quinhydrone electrode, was shown to be practically constant.

The dyes, both in pure water and in alum solutions were examined with a Zeiss cardiod, glycerine immersion, and with a Zsigmondy slit ultramicroscope to determine the state of dispersion of the foreign materials. Some colloid particles were detected in each case, but there appeared to be no relation between the number of particles and the action of the dye in repressing the face displacement. It would seem, therefore,

that the individual dye molecules rather than colloidal aggregates of them, are responsible for the effects observed. Further studies in this direction are at present being carried out with the aid of the ultrafilter.

Table I lists the results of the preliminary experiments. A typical series of measurements obtained as indicated under the experimental

TABLE IV

SUMMARY OF RESULTS

Dye added to solution	Concen. g./100 cc.	Ratio	Deviation (%)
Pure alum solution		1.51	−1.3
" " "		1.55	+1.3
" " "		1.43	−7.0
" " "		1.55	+1.3
" " "		1.56	+1.9
Bismarck brown	0.005	1.50	−1.9
" "	0.005	1.58	+3.1
" "	0.01	1.64	+7.2
Asparagine	0.5	1.50	−1.9
Phenylaminoacetic acid	0.2	1.50	−1.9
Gelatin	0.125	1.66	+7.9
Gelatin	0.25	1.46	−4.9
Gelatin	0.5	1.54	+0.7
Crystal violet	0.0006	1.52	−0.7
" "	0.0025	1.46	−4.9
Formalin	1 cc.	1.48	−3.1
No dye	General average	1.53	±3.2
Diamine sky blue FF	0.00125	1.56	
" " " "	0.0025	1.091	
" " " "	0.00375	0.238	
" " " "	0.005	0.187	
" " " "	0.01	0.129	
Oxamine blue B	0.00042	0.550	
" " "	0.00084	0.145	
" " "	0.005	0.000	
" " "	0.01	0.000	
Anathraquinone green	0.00125	1.56	
" "	0.0025	1.40	
" "	0.005	1.25	
" "	0.0075	0.960	
" "	0.01	0.725	

procedure is given in Table II. At the head of the table are stated the experimental conditions and the appearance of the crystal at the end of the experiment. Under the heading (100) are the values for the distances between the cube faces on the projected image. The figures under the heading (111) represent analogous values for the octahedral faces. In Table III the results of the hydrogen-ion concentration determinations are given. E. obs. indicates the value of the voltage read on the potentiometer while in the second column the p_H values are stated. In Table IV is found a general summary of all experiments. The headings are self-explanatory except that in the last column the

deviation refers to the general average value of the (100)/(111) ratio for 16 cases in which the crystal underwent no change in physical properties. The values in Table II are shown graphically in Fig. 1. In Fig. 2 the values for the ratios in the third column of Table IV are shown graphically, while in Fig. 3 these values are plotted against the corresponding dye concentrations.

Discussion

It is proposed to elucidate the results of these experiments on the basis of the adsorptive forces of the residual valencies in the crystal faces; the polar groups in the adsorbed material; and the inter-ionic distances in the crystal lattice.

Niggli[29] has advanced an illuminating discussion of the growth of crystals. Beginning with the space lattice of the sodium chloride type, Niggli pictured the residual valencies as having components in the six directions of a cube. It is shown that planes passing through such a lattice vary in density of population by ions, and that just below the plane which comprises the crystal face, there is a layer of ions whose residual valencies are not all brought into play. The velocity of perpendicular displacement of a face is proportional to the thickness of such a layer, which is maximal for the vicinal faces and zero for the more prominent faces.

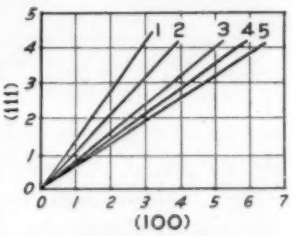

FIG. 2*d*.—Anthraquinone green.

No.	Expt.	Ratio	Dye Concentration
1	E–3	0.725	0.01g.
2	E–5	0.960	0.0075
3	E–4	1.25	0.005
4	E–2	1.40	0.0025
5	E–1	1.56	0.00125

Keenen and France (*loc. cit.*) explained the adsorption of dyes by potassium alum as being due to an attraction between the residual valencies in a crystal face, and the polar groups in the adsorbed material.

It seems probable, however, that only the ions actually in the crystal face exert an adsorptive effect on the dye. The unused valencies in the crystallographically unsatisfied layer beneath the crystal face are probably used almost entirely to cause perpendicular face displacement. The evidence for this is that adsorption of dyes never takes place on vicinal faces. In a face populated by one kind of ion there is a strong adsorptive effect provided the thickness of the unsatisfied layer is zero, whereas in a face populated equally by oppositely charged ions, there is a partial polarization of the residual valencies where these overlap. If crystal growth were due to the whole of the residual valence forces, one should expect the (110) and the (111) faces to grow outward most

[29] *Z. anorg. Chem.*, **110**, 55 (1920).

rapidly, whereas, they are the slower growing faces. Vicinal faces have the greater velocity of perpendicular displacement probably because the displacement of the face follows stepwise, and is therefore, in opposition to the law of parallel face displacement.

In general it seems that the growth forces are greater than adsorptive forces, hence vicinal faces disappear as the crystal grows, and for this reason adsorption takes place only on the prominent faces. Adsorption takes place on faces populated by like ions because the forces are stronger on them than on faces of the "checker-board" type where the residual valencies are partially polarized. While these hypotheses explain many of the growth phenomena of crystals, they do not appear to adequately account for the widely different results obtained in the adsorption of various substances at crystal-solution interfaces. It seems necessary therefore, in order to account for the specificity of such adsorption to extend the hypotheses so as to include considerations of the size of the ions and the inter-ionic distances in the crystal lattice; the nature of the residual force fields in the polar groups of the adsorbed material and also their spatial arrangement within the molecule.

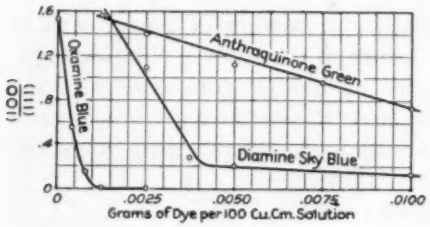

FIG. 3.

With the theory thus briefly outlined we may advance evidence from previous experimenters to confirm these ideas. Retgers[30] found that five of the common alkali halides were caused to assume the octahedral form by the adsorption of foreign materials, although no one adsorbent affected all the salts, nor was any one salt affected by every adsorbent. The octahedral face in this type of lattice is occupied by like ions, and its displacement was repressed. Formamide, according to Korbs[31] produced octahedra from sodium chloride, but not from potassium chloride. Since the type of crystal lattice is alike in all these cases, the specific action must be related to the inter-ionic distances in the lattice. In general, wherever there is adsorption, the displacement velocity of the face on which adsorption takes place is repressed.

From a consideration of one of the crystal structures proposed for the alums,[32] it will be seen that the (100) faces correspond, with respect to population by like ions, to the (111) faces of sodium chloride, hence it should be expected that the cube face displacement should be re-

[30] *Z. physik. chem.*, **9**, 267 (1892).
[31] *Ibid.*, **43**, 451 (1907).
[32] Vegard and Schjelderup, *loc. cit.*

pressed. Most striking evidence for the theory advanced is found in the fact that dyes color only the cube faces of ammonium alum and in the "hour-glass" forms so produced. The double hour glass or maltese cross form shown in Fig. 4 indicates clearly the specificity of the adsorption. The diamine sky blue is adsorbed exclusively by the (100) planes thus leaving the (111) planes clear and colorless.

Adsorption is apparently closely related to crystal growth in the case studied. Thus in the experiment previously described, potassium alum crystals adsorbed no dye when suspended in a saturated alum solution colored with dyes, the experiment being so arranged that no evaporation took place. The nature of the forces causing adsorption on a crystal face at equilibrium must be different from those prevailing during the growth process. During growth one may imagine that the whole crystal face is not ionically plane, but that all over the face columns of ions are building up. This concept is not in conflict with the law of parallel face displacement, for each column may be considered as a crystal in itself. The solution pressures of such points would probably be such that they could not grow large enough to prevent the displacement of the face as a whole. The distance between two such ionic columns would depend on the interionic distances in the lattice. If now the distances between two such columns and the distance between polar groups in the adsorbed material were just right, adsorption of the foreign material across two of these columns could take place. Under these conditions when the crystal face is covered with a mono-molecular layer of dye, the thickness of such a layer in all probability would not be the thickness of the dye molecule, for other ionic columns could grow up between the adsorbed molecules to be capped in turn by adsorption of more dye molecules. One could consider the dye then, not as fitting into the space lattice, but rather as taking the form of molecular inclusions. These molecular inclusions differ from the ammonium alum-crystal violet type (Table I) in that the former are oriented in an orderly manner, whereas the latter are grosser inclusions arranged at random throughout the crystal.

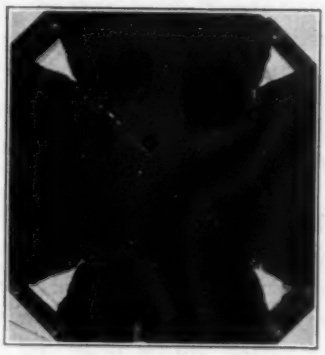

FIG. 4.—Double hour-glass pattern produced by adsorption of diamine sky blue at (100) faces. The dark areas of the (111) faces are uncolored and appear dark in the photograph only as the result of the reflection of the light from these surfaces.

The break-points in the ratio-concentration curves (Fig. 3) probably correspond to a layer of dye molecules approximately one molecule

deep. The uncovered portions of the crystal face continue to grow as ionic columns until they add on new dye molecules, and for this reason the curves in Fig. 3 attain a minimum value not equal to zero. Measurements are at present being made in an attempt to determine the thickness and distribution of the adsorbed layers of dye.

The work presented in this paper is in harmony with the idea that if a given substance is going to be adsorbed by a growing crystal, the most pronounced adsorption will occur at those crystal faces populated by like ions rather than at those of unlike ions. It would seem, therefore, that the study of such adsorption effects would be of value in determining the correct space lattice of a given compound when the results of an X-ray analysis indicate more than one possibility. Thus for example, Reinders[33] observed that silver chloride assumes dendritic forms under the influence of adsorbed methylene blue, congo corinth, marine blue, and other dyes.

Wyckoff[34] states that the crystal structure of silver chloride has not been definitely determined yet, but that it is either of the sodium chloride or zinc sulphide type. If the structure were of the sodium chloride type, any repression should produce octahedra, and if of the zinc sulphide type the repression should produce cubes. Since the dendritic forms observed by Reinders most likely result from the parallel growth of cubes it seems probable that silver chloride has a lattice of the zinc sulphide type.

The application of the powder method of X-ray analysis[35] to the study of colloid systems leads to the conclusion that the dispersed particles of most colloid systems are small crystals. It seems quite probable then that the same factors governing the adsorption at crystal-solution interfaces as herein presented may also be effective in determining the limiting size of suspensoid colloidal particles, the stability of the system, and the apparent specific action of electrolytes in the flocculation of the dispersed phase. An investigation of these points is now in progress in this laboratory.

Summary

(1) The ratio of the perpendicular displacement of cube to octahedral faces of ammonium alum was found to be 1.53.

(2) Diamine sky blue, oxamine blue, and anthraquinone green are adsorbed on the cube faces only, and at the same time repress the displacement of these faces.

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[33] Reinders, *Z. physik. chem.*, **77**, 212 and 677 (1911).

[34] Wyckoff, The Structure of Crystals, pp. 315–16. Chem. Catalog Co., Inc. 1924.

[35] Scherrer, Nach. Ges. Wiss. Göttingen (1918) 96.

(3) Striking "hour-glass" figures were obtained with diamine sky blue and potassium alum. Adsorption takes place only when the crystals grow.

(4) The mechanism of adsorption is explained on the basis of residual valencies, polar groups in the adsorbed material, and inter-ionic distances in the lattice.

(5) Specificity of adsorption is accounted for on the concept of "ionic-columns" on the face of a growing crystal.

(6) The use of adsorption effects at crystal solution interfaces as an aid in the selection of the correct space lattice from a number of possible types has been suggested.

(7) The suggestion has been made that possibly the factors governing the adsorption at crystal-solution interfaces are also effective in determining the limiting size of suspensoid particles, their stability and reaction toward electrolytes.

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ELIMINATION OF SEGREGATION IN DRUMS[1]

By G. J. Easter and G. M. Magrum

ABSTRACT

Segregation of grits of different sizes was practically eliminated by the insertion of small tangential cylinders (3-inch diameter) extending from top to bottom of the drum while it was being filled.

Introduction

In filling a container with any dry granular material of nonuniform size the coarser grits tend to concentrate at the outer edge and the finer grits in the center. This is because as the material builds up from the bottom it forms a conical heap, down the sides of which the subsequent particles roll. The larger particles have more momentum and hence roll further than the small ones before coming to rest. This segregation presents a serious problem to the maker of ceramic wares who wishes to maintain strict uniformity of product.

Previous Devices

The problem of its elimination has been given study previously and some very interesting results are presented by T. W. Garve[2] who has shown among other devices the division of the bin into four compartments by vertical partitions, each compartment being filled by a separate spout. This was found to lessen segregation in the bin itself to some degree but to be ineffective in preventing further segregation as the bin was discharged, as there was still appreciable segregation in the bin and the outlet discharged the material directly above it before grits from other horizontal areas.

Use of Close Partitions

In an effort to improve upon this scheme and particularly to utilize it in connection with kegs and similar containers where the material is not allowed to flow through but is removed by scoops from above, the present writers have subdivided the container considerably more closely using for this purpose a number of small (3-inch diameter) tangential cylinders extending from top to bottom of the container and designed to be filled from a single spout. These cylinders were fastened together so that they could later be withdrawn as a unit. (See Fig. 1.)

When the drum containing these cylinders is placed in a stream of descending grain, the cylinders immediately in the stream are first

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Refractories Division.) Received February 27, 1928.

[2] T. W. Garve, "Segregation in Bins," *Jour. Amer. Ceram. Soc.*, **8** [10], 666–70(1925).

filled after which the grain rolls over into the next surrounding series of cylinders which are then filled completely before the next successive ring is brought into use, and so on until the keg is full.

An alternate method would be of course to use concentric rather than tangential cylinders but this seemed to offer some chance of lateral cone formation if the descending grain did not strike the center cylinder directly and evenly and so was passed over for the scheme using separating partitions in all directions.

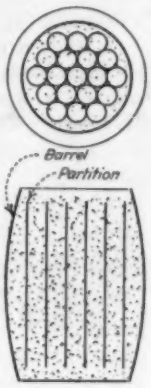

FIG. 1.

Test Results

As a test of the efficacy of this arrangement, equal weights of two widely different sizes of abrasive grain (20 and 40 grit) were very thoroughly mixed together and then sifted into a conical hopper which discharged immediately above the center of the test keg. A duplicate run was made with an ordinary keg without the use of partitions.

After removing the cylinders samples were taken from each keg with a sampling thief inserted vertically at the center and near the periphery and all samples carefully screen analyzed.

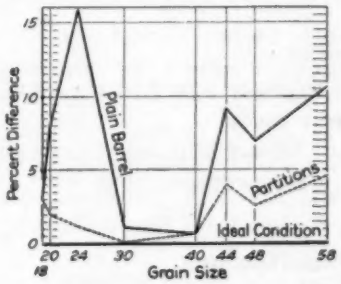

FIG. 2.

In Fig. 2 the results of these analyses are shown graphically. In each case there was a concentration of coarse grits toward the outer edge and of fines in the center. The difference between the percentage of grit of each size at these two points is used as the basis of the graph.

It will be noted that the segregation has been very materially decreased by use of the vertical partitions. The solution has proved satisfactory in the case of kegs, and if desired, could probably be extended to use in bins, etc.; inasmuch as the grit mixture is alike in each vertical tube it would make no difference which was discharged first.

CARBORUNDUM COMPANY
NIAGARA FALLS, NEW YORK

RAW YELLOW GLAZES FOR TERRA COTTA AND DEVELOPMENT PHENOMENA[1]

By L. R. Squier

ABSTRACT

A study made for the purpose of developing raw yellow colors for terra cotta, using two glaze bases with rutile, barium chromate, and uranium oxide introduced as sodium uranate, is described. Results obtained and development phenomena observed are discussed.

Purpose of Investigation

The investigation began with the intention of developing more intensely yellow glazes for terra cotta polychrome, both raw and calcined. As they were developed, phenomena were observed in the raw colors which were sufficiently interesting for a discussion. This paper deals only with the raw colors developed and discusses the phenomena for raw yellow colors, although the conclusions drawn are applicable to all raw glazes and colors, and, to a modified degree, to calcined ones as well.

The results of the investigation rather than the methods of investigating are presented; therefore most of the inconsequential tests are omitted. Batch formulas only were used, and the procedure is incorporated in the results in order to form a practical, rather than a theoretical discussion.

Method of Procedure

All glazes were pebble-ground and fired to cones 5 to 6 in the usual muffled terra cotta kilns. No underslips were used.

Two types of glazes were used: (1) an Albany slip and Cornwall stone glaze, I, and (2), a Bristol glaze, II, whose compositions were as follows:

I		II	
Albany slip	16	Potash feldspar	53
Cornwall stone	84	Flint	18½
		Eng. china clay	4½
		" ball "	4½
		Calcium carbonate	6½
		Barium carbonate	13
			100

These glaze bases were depended upon, not so much for their ability to give finished product glazes as to furnish glazes whose constituents could be manipulated to permit of advantageous or deleterious effects upon the color and color intensity. It was discovered very early in the investigation that the selection of the proper glaze base was fully as important as the selection of the coloring material.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, February, 1928. (Terra Cotta Division.)

The coloring agents used were (1) rutile, (2) barium chromate, and (3) uranium oxide, introduced by the addition of sodium uranate (the latter is implied where the introduction of uranium is mentioned).

Results

(A) Rutile (1) Ten and one-half per cent of rutile in glaze I afforded a brownish buff color, and variations in the proportions of Albany slip and Cornwall stone to 71% of the former and 29% of the latter furnished no appreciable change in color; doubling the rutile content gave a buffish yellow. To glaze I containing $10^1/_2$% rutile, zinc oxide was added and increasing amounts changed the color from the brownish buff, through a buff, to a straw yellow. All were opaque, of semifull glaze texture.

(2) No good results were obtained with rutile in glaze II until zinc oxide was substituted for the calcium carbonate content. A bright, opaque, yellow-buff was then produced. Increases of zinc oxide, and also of flint, lightened the color.

(B) Barium Chromate (1) In glaze I, 5% barium chromate gave a brown unglazed finish, but with the addition of 12% zinc oxide a bright opaque, brown-yellow was produced. An increase of zinc oxide and the addition of flint made the glaze more full and the color a tan-buff. Adding rutile changed the color, as would be expected, to a lighter color, a tan-yellow.

(2) In glaze II, $1^1/_2$% of barium chromate with 15% rutile produced a mat, buff-yellow, with a slight greenish tint. No yellow glaze was produced with barium chromate alone, probably because the glazes were all too basic.

(C) Uranium Oxide (1) Eight per cent uranium oxide in the Albany slip-Cornwall stone glaze I produced a dark greenish-gray. When the proportion of the constituents of glaze I was changed to Albany slip 71%, Cornwall stone 29%, the same percentage of uranium oxide gave a full, rich, red-brown color. This change in color is undoubtedly due to the increased manganese and iron of the higher Albany slip content. Manganese in conjunction with uranium, does produce browns. Calcium carbonate changed the red-brown toward a chocolate brown, seemingly indicating, with past experience with uranium and calcium, either that a stable coloring compound of uranium had been formed or that manganese counteracted the effect of the calcium, the action of the calcium on the color being negligible. Additions of zinc afforded no more than a greenish tan-yellow. It may be here noted that variations of uranium and zinc in glaze I produced brownish maroon-reds.

(2) In glaze II, 6% uranium oxide gave the nonuniform greenish yellow so familiar to those who try a high uranium oxide content in Bristol glazes. On substituting zinc oxide for the calcium carbonate content, a brilliant yellow resulted, with but a very pale greenish tint and this color fired very uniformly, with no green edges on the sample, which are so often seen when uranium is used in ordinary Bristol glazes. The zinc oxide content in the same glaze was doubled, and a bright lemon yellow was the result. Halving the uranium oxide in the former yellow produced a color, intermediate between that and the lemon-yellow.

Substituting additional barium carbonate for the calcium carbonate in glaze II, then cross-blending with the glaze containing double the zinc oxide equivalent of the calcium carbonate of glaze II, with 6% uranium oxide in both, a series of glazes was obtained in which the zinc oxide gradually increased at the expense of the barium carbonate. This showed that there is a maximum percentage of zinc oxide which will permit the greatest intensity of yellow from uranium in the glaze. When magnesium carbonate was substituted for the barium carbonate in the glaze where zinc oxide replaced the calcium carbonate in glaze II, a dark greenish gray was produced, again with 6% uranium oxide.

Conclusions

(A) Raw Yellow Glazes (1) Calcium, magnesium, and the improper amount of zinc, should not be used with uranium oxide when a yellow glaze is desired, while barium and a certain percentage of zinc, dependent upon the amount of uranium and the composition of the remainder of the glaze, are advocated to produce intense yellows in modified Bristol glazes. Calcium and magnesium appear to act as catalyzers for the reduction of yellow and orange uranium oxide to greens and grays, at high temperatures.

(2) Calcium and zinc affect rutile in glazes in the same way that uranium is affected.

(B) Phenomena Observed (1) Colors resultant from the introduction of coloring materials in a glaze are dependent upon the composition of the glaze used, as well as the amount and composition of the coloring material.

(2) From the economical aspect, lesser amounts of expensive coloring materials may often be used to furnish similar colors by manipulation of the glaze base.

NEW JERSEY TERRA COTTA COMPANY
PERTH AMBOY, N. J

THE USE OF 8-HYDROXYQUINOLINE FOR THE CHEMICAL ANALYSIS OF SILICATES[1]

By Josef Robitschek

ABSTRACT

A method for the gravimetric and titrimetric determination of different metals, devised by Berg, is used for the analysis of silicates. Alumina and magnesia are precipitated with 8-hydroxyquinoline and the precipitates can be either dried and weighed or dissolved and titrated. Both metals can be determined in the presence of silica and thus much time is saved, if determination of the silica is not required. For different purposes different methods have been devised and very accurate results have been obtained.

Introduction

Disadvantages of Older Methods

The time required for the complete chemical analysis of a silicate is long. Inspection of raw materials and finished products in the plant laboratory is, in most cases, of little value if it requires too much time. Besides accurate results are possible only by one in constant practice.[2]

Use of 8-Hydroxyquinoline

R. Berg[3] and Hahn and Vieweg[4] have recently published a method for the determination of alumina and other metals in the presence of silica. Furthermore, by this method the determinations of alumina and magnesia can be greatly shortened. No second precipitation of alumina is required and no removal of ammonia is necessary in the magnesia determination.

The methods are based on the fact, that the 8-hydroxyquinoline gives precipitates which are nearly insoluble; in the case of aluminium $Al(C_9H_6ON_3)_3$; of magnesium, (if dried at 140°C) $Mg(C_9H_6ON_3)_2$. The precipitates may be dried and weighed or dissolved in dilute hydrochloric acid and titrated.

Determination of Alumina

Method Used

If alumina alone is to be determined, this can be done by titration without separating the silica.

For titrimetric determination of alumina, the silicate is fluxed in the usual way, the cake dissolved, the solution neutralized, and then acidified with acetic acid. After adding ammonium acetate, the aluminium is precipitated with oxychinolin acetate. After filtering, the oxychinolin acetate is washed out, the precipitate is dissolved in hydrochloric acid and to this solution a surplus of a potassium

[1] Received December 17, 1927.

[2] Robitschek, *Tonind. Ztg.*, **51**, No. 63 (1927); Blum, Bur. Stand., *Sci. Paper*, No. 286 (1916).

[3] Berg, *Zeits. f. anal. Chem.*, **70**, 341, **71**, 23, 369 (1927).

[4] Hahn und Vieweg, *ibid.*, **71**, 122 (1927).

bromide-bromate solution is added. The surplus of bromine, which has not been consumed by the oxychinolate, can be determined by titration with a solution of $Na_2S_2O_3$, after potassium iodide has been added.

The Method in Detail

The Precipitation Too large amounts of acetic acid lessen the accuracy of the determination. The solution should not contain more than 0.5 cc. of free concentrated acetic acid per 100 cc. Then to the cold solution 3 to 5 grams of ammonium acetate and a surplus of a solution of 2 grams of 8-hydroxyquinoline in 100 cc. of water are added.

Preparation of Solution The solution of oxychinolin acetate is prepared by grinding 25 grams of 8-hydroxyquinoline with 25 grams of acetic acid, diluting the same with hot water to 1000 cc., adding dilute ammonia until a clouding of the liquid appears. After the liquid has cooled, it is filtered. Of course a chemically pure hydroxyquinoline must be used.

Filtration and Washing After adding oxychinolin acetate, the liquid is heated to a temperature of 70°C until the precipitate has become crystalline. If highly accurate results are required, the liquid must be cooled before filtering for aluminium-oxychinolate is more soluble in hot solution. If the analysis needs to be carried out within a very short time and accuracy is not imperative, the hot solution can be filtered.

The precipitate is washed with hot water until the water leaves the filter colorless. Then the precipitate is dissolved in hot, dilute hydrochloric acid (1:3) and the solution titrated.

Titration The titration is carried out by the method of Koppenschaar[5] for the titration of carbolic acid. By adding bromine to the above solution, 5–7 dibromoxychinoline is formed according to the equation

$$C_9H_7ON + 2Br_2 = C_9H_5ONBr_2 + 2HBr \qquad (1)$$

Instead of bromine a solution of potassium bromide and bromate is used, which reacts with hydrochloric acid according to the equation

$$KBrO_3 + 5KBr + 6HCl = 6KCl + 3H_2O + 3Br_2 \qquad (2)$$

The bromine formed reacts with the oxychinoline according to equation (1).

The titration is therefore carried out as follows: After dissolving the precipitate and cooling the solution, 50 cc. of a $N/5$ KBr–$KBrO_3$ solution[6] are added from a burette.

[5] Koppenschaar, *Zeits. f. anal. Chem.*, **15**, 233 (1876).

[6] According to Koppenschaar this solution is prepared by dissolving 5.5674 grams of potassium bromate, which has been dried at 110°C and 20 grams of potassium bromide

A few cubic centimeters of a concentrated solution of potassium iodide are then added. An amount of iodine equivalent to the free bromine is formed; the iodine combines with the dibromoxychinoline forming an insoluble compound, which reacts with the $Na_2S_2O_3$ just like the compound formed by addition of iodine and starch. Fifth normal $Na_2S_2O_3$-solution is added drop by drop from a burette, until the precipitate has dissolved, then starch and more $Na_2S_2O_3$ are added, till the blue color disappears. One cubic centimeter of the $N/5$ $KBrO_3$–KBr-solution is equivalent to 0.000849 gram Al_2O_3.

TABLE I

Substance	Determination No.	Tested according to A.S.T.M. gravimetric method (%)Al_2O_3	Determined according to Berg's Method: Hot filtration (%)Al_2O_3	Determined according to Berg's Method: Cold filtration (%)Al_2O_3
Clay No. I	1	37.84	37.84	37.78
	2	37.88	37.80	37.76
	3	—	37.83	37.78
Clay No. II	1	29.73	29.75	29.70
	2	29.84	29.75	29.69
	3	29.80	29.76	29.70
Glass	1	0.89	0.88	0.80
	2	0.88	0.88	0.81
	3	—	0.87	0.80
Fire brick	1	41.24	41.25	41.18
	2	41.35	41.27	41.16
	3	—	41.21	41.16
Slag	1	11.03	11.05	11.00
	2	11.09	11.03	11.01
	3	—	11.06	10.98

Results Obtained

In Table I are data which prove the accuracy of this method. The author has used this method for a great number of determinations; each determination has been carried out twice and the difference between two determinations was never greater than 0.08%; in most cases this difference was 0.02 to 0.03%. The accuracy of the method was therefore dependent only upon the accuracy of the burette readings.

Advantages of New Method

Much time is saved by using this method. Even when working very fast, the determination of alumina by the old method can not be made in less than two days. If the determination must be finished quickly, the alumina can be determined within one and one-half hours by this new method.

The advantages of the new method, saving of time and a greater accuracy, are evident.

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to 1000 cc. This solution should be compared with the $N/5$ $Na_2S_2O_3$-solution by iodometric determination of the bromine which is formed by adding hydrochloric acid to the solution.

The Complete Analysis

Method Used Because of the great accuracy of the determination of metals with 8-hydroxyquinoline, the author tried to use these methods where more than one of the components of the silicate were to be determined. Here also the method gave excellent results and apparently can be used for the complete analysis of silicates with success.

The silica is determined in the usual way.

Determination of Alumina The alumina is precipitated as aluminium oxychinolate in the manner described. After precipitation and cooling, the liquid is filtered through a weighed glass filter crucible (Jena, <7). The precipitate is washed with a little hot water, until the latter shows no color, then with cold water, until the chlorine-reaction disappears. The precipitate is then dried at 110°C and weighed. To avoid losses, only very little hot water should be used for the washing. After drying, the precipitate contains 11.07% Al_2O_3, according to the formula $Al(C_9H_6ON)_3$.

Determination of Lime After the alumina has been separated, the calcium is precipitated as the oxalate. The presence of acetic acid and oxychinoline does not influence the results. The calcium oxalate must be dissolved and precipitated again, to get accurate separation of lime and magnesia.

Determination of Magnesia If the magnesia content is large, oxychinolin acetate must be added to the filtrate otherwise the amount contained in solution will suffice. Three to five grams of sodium tartrate are added to the solution and the magnesium oxychinolate is precipitated by neutralizing the solution with an excess of dilute sodium hydroxide. After heating to 70°C and cooling, the liquid is filtered. The precipitate is washed with a 1% sodium tartrate and sodium hydroxide solution. Finally, the sodium tartrate is washed out with cold water. As the precipitate is slightly soluble in cold water, only small amounts of water should be used. Then the precipitate is dried and weighed or dissolved and titrated.

If the precipitate is to be weighed, a glass filter crucible is used, otherwise a filter paper. The precipitates filter easily.

The titration is carried out in the same way as for alumina. One cc. of a $N/5$ $KBrO_3$–KBr-solution equals 0.001008 gram MgO.

If the magnesia is to be determined by weighing the precipitate, one must bear in mind, that the precipitate contains two moles of water when dried at 105°C. If the precipitate is dried at 130 to 140°C, the combined water is driven off and one gram of the precipitate contains 0.1290 gram MgO. The gravimetric determination may be checked by dissolving the magnesium oxychinolate in dilute hydrochloric acid and determining it once more by titration.

It is also possible to precipitate the magnesia with 8-hydroxyquinoline in the presence of lime from a hot solution, containing ammonia and in the presence of alumina from a solution containing sodium tartrate and sodium hydroxide. These methods are described by Berg.

Iron oxide and titania are best determined from a second sample according to the usual methods.

Results and Advantages of New Method

A few results obtained by the method described here and that of the A.S.T.M. are given in Table II. The two methods agree very closely. Using the new method, much time is saved. The determination of alumina, lime, and magnesia together take only one day, whereas their determination by the old method requires two to three days.

TABLE II

Substance	Component	Gravimetric method Using 8-hydroxyquinoline Anal. I (%)	Gravimetric method Using 8-hydroxyquinoline Anal. II (%)	Method of A.S.T.M. (%)
Clay	SiO_2	44.96	44.87	44.92
	Al_2O_3	37.90	37.93	38.01
	CaO	0.96	0.96	0.92
	MgO	0.24	0.24	0.22
Fire brick	SiO_2	67.92	67.80	67.84
	Al_2O_3	27.85	27.82	27.89
	CaO	0.75	0.75	0.79
	MgO	0.37	0.36	0.33
Glass	SiO_2	70.11	70.60	70.61
	Al_2O_3	0.82	0.80	0.84
	CaO	11.27	11.38	11.32
	MgO	1.65	1.67	1.62

A series of determinations of magnesia in technical glasses has shown that the determination of magnesia with 8-hydroxyquinoline gives results of surprising accuracy. These results seldom differ by more than 0.02% and are somewhat (approximately 0.04%) higher than those obtained by using phosphate for the precipitation of magnesia.

Determination of the Alkalis

Description of Method

From 0.5 gram of sample the silica is separated by evaporation with hydrofluoric and sulphuric acid. The residue is dissolved in hydrochloric acid and 200 cc. of hot water. A surplus of oxychinolin acetate is added and the hot solution is neutralized with excess of ammonia and the liquid is kept at 70°C until the precipitate has become crystalline. After cooling, the liquid is filtered, the precipitate dissolved and precipitated again. The precipitate is then washed with cold water containing some ammonia.

After sulphuric acid has been added, the filtrate is evaporated, the residue heated to 600°C and the sulphates of the alkalis weighed.[7]

Results Some of the results of these determinations are given in Table III. The results were checked by a method given by Schürmann and Schobb,[8] which is the only method giving an exact determination of small amounts of alkalis in silicates.

TABLE III

Substance	Method Schürmann-Schobb		Using 8-hydroxyquinoline		
	I (%)	II (%)	III (%)	IV (%)	V (%)
Clay No. I	0.62	0.61	0.59	0.62	0.59
Clay No. II	0.80	0.82	0.79	0.79	0.84
Fire brick I	0.32	0.35	0.30	0.35	0.33
Fire brick II	0.43	0.43	0.47	0.45	0.42
Fire brick III	0.93	1.01	1.00	1.04	1.04

The values in Table III show accuracy equal to that of the method by Schürmann and Schobb.

Other Possibilities of Use

Quick Method for Analysis of Glasses E. C. Sullivan and W. C. Taylor[9] have proposed a method for the analysis of glasses, which was supposed to permit a very fast determination of the components of glasses. The method is based on the use of hydrofluoric and oxalic acid for the removal of silica. The author has also used this method but has given it up as the results are not very accurate and little time is saved. If this method is combined with the use of 8-hydroxyquinoline, it is possible, to determine alumina, lime, and magnesia in glasses in a very short time.

Analysis of Soda-Lime-Glass One gram of the powdered glass is heated with 2 grams oxalic acid and a few cc. of hydrofluoric acid in a platinum crucible. An air-bath described by Hillebrand[10] and consisting of a large iron crucible is used, in which the platinum crucible is laid. After the hydrofluoric acid has been evaporated, the residue is twice evaporated with oxalic acid and water, then dissolved in water, and filtered. The residue upon the filter consists of calcium oxalate and some undissolved silica, so that the

[7] Qualitative determinations of alumina, lime, magnesia, iron oxide, and titania proved the absence of these in the residue. Some determinations were also carried out without redissolving the precipitate of the oxychinolates. The values for the alkalis were 0.03 to 0.05% lower than in the case of twofold precipitation. The error caused by this simplification is so small, that in most cases the oxychinolate need not be reprecipitated. Then the amount of ammonia salts in the solution is small and the evaporation does not take much time.

[8] Schürmann and Schobb, *Chem. Ztg.*, 1925.

[9] Sullivan and Taylor, *Ind. Eng. Chem.*, **6**, 897 (1918).

[10] Hillebrand, "The Analysis of Silicate and Carbonate Rocks," U. S. Geol. Surv., *Bull.*, No. 700.

lime can not be determined gravimetrically. The residue is washed with hot water, until a few cc. of the water do not discolor one drop of a $N/10$ $KMnO_4$ solution. Then the residue is dissolved in dilute sulphuric acid and the calcium-oxalate is determined by titration with $N/10$ $KMnO_4$ solution.

The filtrate is evaporated in a platinum dish and heated to red heat; thus the oxalic acid is destroyed. The residue is dissolved in hot hydrochloric acid and filled up to 500 cc. The solution always contains some silica, wherefore the determination of alumina and magnesia must be carried out by titration. This is only possible, if 8-hydroxyquinoline is used. In Table IV are comparison of data by the two methods.

TABLE IV

Substance	Analysis No.	Using 8-hydroxyquinoline for rapid determinations			A.S.T.M. Method		
		(%) CaO	(%) Al_2O_3	(%) MgO	(%) CaO	(%) Al_2O_3	(%) MgO
Glass No. I	1	11.54	0.82	1.60	11.42	0.88	1.64
	2	11.50	0.82	1.61	11.50	0.89	1.67
	3	11.63	0.80	1.59	11.50	0.90	1.63
Glass No. II	1	11.80	0.50	1.80	11.68	0.58	1.87
	2	11.78	0.51	1.82	11.68	0.50	1.89
	3	11.84	0.50	1.83	11.65	0.57	1.84
Glass No. III	1	10.02	3.63	0.20	9.97	3.87	0.24
	2	10.07	3.64	0.20	9.93	3.79	0.18
	3	10.09	3.66	0.20	10.01	3.78	0.20

By using the fast method, the results for lime are somewhat too high and those for alumina too low. Probably the calcium oxalate occludes small amounts of aluminium and magnesium oxalate. No effort was made to improve upon the precision of these determinations by dissolving the calcium oxalate and precipitating it again. This would require more time and the method shall serve only when it is desired to make the inspection of the plant product quickly.

Other Possibilities The 8-hydroxyquinoline can doubtless be used for many other purposes. An exact determination of small amounts of copper, iron, and other minor constituents of colored glasses can be made with it, for the exactness of the titrimetric determinations is large enough for such purposes. No doubt, a method for the gravimetric and titrimetric determination of lime in silicates with 8-hydroxyquinoline can be devised. The methods described above can be modified, furthermore, so that they could apply on different special problems.

Acknowledgment

The results given in the Tables I to IV are only a part of the determinations which have been conducted for several months. The use of the 8-hydroxyquinoline has proved an excellent help for fast and correct work. The author wishes to acknowledge the kind assistance and practical advice given to him by L. Hahn and especially by R. Berg. It

is due to them, that methods for precipitation of metals with 8-hydroxyquinoline have been devised. The writer has tried to prove that these methods can be used with great advantage for the analysis of silicates and has outlined special methods for this purpose.

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Discussion

G. E. F. LUNDELL: The use of 8-hydroxyquinoline in the analysis of ceramic materials offers interesting possibilities. At the present time however, too little work has been done to warrant all of the claims made in Mr. Robitschek's article. Researches on the behavior of the reagent that have been published since Hahn[1] recommended its use, have had more to do with successful applications in pure than in impure solutions. Consequently, while it is claimed that the determination of aluminum is entirely satisfactory, nothing has been published concerning the effect on the determination of such substances as iron, manganese, titanium, zirconium, boron, phosphorus, or arsenic. Similarly, nothing is known concerning the behavior of these substances in the method that is proposed for the determination of magnesium, if they do not accompany aluminum.

To the analyst of ceramic materials the most interesting feature of the paper will probably be the method that is recommended for the determination of the alkalis. But here also, the work is far from complete. If the method is to succeed, substances such as CaO, MnO, Fe_2O_3, TiO_2, ZrO_2, P_2O_5, As_2O_5, B_2O_3, and V_2O_5 must be quantitatively precipitated, yet nothing has been published concerning their behavior.

In fairness to the old standard methods for aluminum, magnesium, and the alkalis, it should be said that they are not as bad as is claimed by the author in his enthusiasm for the new methods.

One drawback to the use of 8-hydroxyquinoline in the United States at the present time is its American cost, $14.00 per 100 grams. Possibly the price is much lower abroad, for the cost of the reagent is not mentioned in the foreign articles. At any rate, a more general demand should lead to a much lower price, as was the case with dimethylglyoxime.

[1] F. L. Hahn, *Chem. Ztg.*, **50**, 754 (1926); F. L. Hahn and K. Vieweg, *Zeit. f. anal. Chem.* **71**, 122 (1927); R. Berg, *ibid.*, **70**, 341 (1927) and **71**, 23, 171, 321, 369 (1927).

CERAMIC ABSTRACTS

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[1]The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

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Abrasives

PATENTS

Heat treatment of alumina and other materials. T. S. CURTIS. U. S. 1,662,739, March 13, 1928. A fragmentary body of material such as Al_2O_3 is subjected to the action of an explosive mixture of gas and air which is burned in direct contact with the material to heat it and effect a change in its properties, *e.g.*, to produce Al_2O_3 in crystalline form for use as an abrasive. (*C. A.*)

Abrasive article. WILLIAM BURTON WESCOTT. U. S. 1,668,439, May 1, 1928. An abrasive article composed of granules of abrasive material bonded together by films of gelled latex rubber containing a minor amount of distributed asbestos fiber.

Reinforced abrasive article. WILLIAM BURTON WESCOTT. U. S. 1,668,475, May 1, 1928. In the manufacture of articles composed of or comprising hard rubber, the process which comprises admixing comminuted old rubber, abrasive materials, sulphur and latex solution, drying, molding, and vulcanizing.

Abrasive article. WILLIAM BURTON WESCOTT. U. S. 1,668,476, May 1, 1928. An abrasive article comprising granular abrasive matter bonded by a composite binder carrying reinforcing fiber in random arrangement and a cementing bond layer cohering to the individual grains and also cohering to fiber, the composite binder also comprising a continuous bond of rubber.

Centerless grinding machine. HERBERT VANDERBEEK. U. S. 1,669,728, May 15, 1928. A machine for grinding conical rolls comprising a grinding wheel, a conical

feed wheel, and a work support adapted to support a conical roll between the grinding wheel and the feed wheel, the apexes of the conical roll and feed wheel being located on the same side of the plane of the grinding wheel.

Base grinding-machine wheel. HARRY L. MYERS. U. S. 1,669,994, May 15, 1928. A base grinding machine wheel of the character described comprising a body, a core embedded centrally in the body, the core having a smooth surface socket terminating at its inner end in a screw threaded countersocket, and a nut anchored in the core and disposed in spaced relation to the countersocket.

Grinding machine. RALPH D. GARDNER. U. S. 1,670,111, May 15, 1928. In a grinding machine having opposed grinding wheels movable toward and from one another, means arranged adjacent the wheels for wheel-dressing purposes and adapted to be moved into the normal path of movement of the wheels, and means for limiting movement of one wheel toward the wheel-dressing means during a wheel-dressing operation.

Art

Excavations at Samarra. M. S. DIMAND. *Bull. Met. Mus. Art*, **23** [3], 85–90 (1928).—Samarra, on the Tigris, which existed only 47 years (836–83 A.D.) was first explored by the German scholars, Sarre and Herzfeld. The fragments of pottery found in the débris of the palaces and private houses of Samarra are of the greatest importance to students of Near Eastern ceramic art. A number of these fragments and 4 complete bowls are the property of the Museum. The pottery fragments with luster decoration represent the greatest achievement of Mesopotamian potters of the 9th Century. Pottery with gold luster over relief decoration probably was direct imitation of gold vessels, the use of which is forbidden by the Koran. The most beautiful ceramic ware found at Samarra, consisting of vessels and wall tile, have a rich monochrome or polychrome decoration in brilliant luster painted over a white tin enamel. There are also vessels of ruby luster, often in connection with colors such as yellow, gold, and purple. Perhaps the finest achievement of Samarra luster painting is the tile which decorated the walls of El-Mutasim's palace. The design of the square tile consists of a cock on a yellow marbled background in the center of a circular wreath, in brilliant yellow, dark brown and red luster. The Samarra luster has never been surpassed by any of the Mohammedan countries. Excavations at Samarra establish a new fact of greatest importance, that white porcelain was made in China under the T'ang dynasty (A.D. 618–907) and that Chinese stoneware and porcelain were exported in the 9th Century to the empire of the caliphs. Most of the fragments of porcelain were found in the great palace of the caliphs. Among Chinese ceramics imported by the caliphs are also examples of the familiar stoneware of the T'ang period with splashed or streaked glazes in yellow and green. The importance of the Samarra pieces lies in the fact that they were objects of daily use, while similar ceramics found in Chinese tombs served mortuary purposes. While real Chinese ware was used at the Court, the ordinary citizens of Samarra were satisfied with imitations in faience, fragments of which can be seen in this Museum. The Mesopotamian potters imitated not only white porcelain but also stoneware and their glazes were often of excellent quality and very like Chinese.

A.A.A.

Center of historical studies in Madrid. HOMERO SERIS. *Art and Arch.*, **25** [3], 122–29 (1928).—Illustration of the Moorish vase of the Alhambra which is an example of the highly decorated ceramics of foreign origin. E.B.H.

Mediterranean house in California. JOHN BYERS. *Arts and Dec.*, **28** [6], 64 (1928). —Illustration of bronze door enhanced by border of Spanish tile. E.B.H.

Stained, leaded, and painted glass. MARY MARTIN. *Arts and Dec.*, **28** [6], 73 (1928).—A substitute for leaded glass has been perfected by an American firm. Upon

the glass, mineral colors, mixed with proper chemicals are dissolved and infused by means of the slow heat of the ordinary electric heater. The colors harden to a stonelike surface, transparent and clear. The designs are outlined with a liquid lead to prevent spreading and increase the effect of reality. E.B.H.

Sultanabad pitcher. ANON. *Int. Studio*, **89** [371], (1928).—The cover illustration is a Sultanabad pitcher of the 14th Century. E.B.H.

Early English faience. CHARLES HYDE-JOCELYN. *Int. Studio*, **89** [371], 57–60 (1928).—In the same classification are delft, faience, majolica, and various lustrous bodies decorated over a ground work of opaque tin enamel. Distinguishing the Dutch from the English ware of London at Lambeth, probably founded by Dutch immigrants, are the coarser paste and pinkish shade (resulting from the red of the body showing through the enamel) of the latter, which is also harder and thicker. The hardness causes the pronounced crazing by preventing the keying or embedding of the glaze in the minute holes of the surface. The Lambeth blue is less brilliant than the Dutch. In all cases the actual painting is somewhat crude, having been applied by a sponge or piece of cloth. Lambeth was largely restricted to five colors, blue, green, a brownish purple, orange, and yellow. E.B.H.

Colored and engraved glass. ANON. *Ceram. Ind.*, **10** [5], 508–13 (1928).—For abstract see *Ceram. Abs.*, **7** [4], 204 (1928). F.P.H.

Ceramic photolithography. C. FLECK. *Ceram. Ind.*, **10** [5], 528 (1928).—Photolithography is a photographic process by which all kinds of prints may be, either directly or indirectly, transferred onto stone from which any number of decalcomania prints may be reproduced, either in black and white or in colors, on lithograph presses for use in the ceramic industries. This process is faster, better, and cheaper than copying the design by hand on lithographing stones. Lack of understanding has prevented its development for several decades, greatly to the loss of decalcomania manufacturers. The direct transfer processes consist of: (1) aluminum-chromatograph copying process, (2) enamel copying process, (3) asphalt copying process. Indirect methods of transferring copies onto the stone are: (1) photolithographic transfer by means of (*a*) paper coated with sensitized albumin, (*b*) gelatinized paper. Another practical process is the albumin-chromatograph process for reproducing crayon drawings and autotypic prints. This method was practically demonstrated by A. Poitevin about 1860. Its principle is that adhesive substances harden when bichromates are added and exposed to the light, so that under some conditions they are not soluble in hot water. In this process, albumin is the adhesive, acting as the carrier of the light-sensitizing medium, the chromic salts. The albumin may be used in the dry or fluid state, only one-seventh of the quantity that would be used of the fluid being used of the dry. The formula is: distilled water 100 cc., sodium hydrate (caustic soda) 1 g., clarified albumin fluid 35 cc., ammonium bichromate 1 g. The albumin of chicken eggs is first whipped stiff and then permitted to settle. The clarified mass is used to make the solution. The sodium hydrate bleaches the solution, thereby rendering it more sensitive to the light; moreover, it aids in facilitating development of the albumin copy. In place of the sodium hydrate, caustic ammonia may be used, but its odor is apt to be injurious to sensitive nerves. The solution must be filtered before it is used. Before preparing a double-polished stone, it is best to make certain with a steel rule that the stone has a plane surface, and that it has been well seasoned. The stone may be air-dried in sunlight, or, in winter, in a kiln. F.P.H.

Uranium-red glazes. K. ZIMMERMAN. *Keramos*, **7** [2], T4 (1928).—For abstract see *Ceram. Abs.*, **7** [4], 208 (1928). F.P.H.

Artistic principles in glass staining. PAUL SCHMUDE. *Diamant*, **49** [35], 686–88; [36], 708–12 (1927).—In glass staining there must be an adaptation of the subject to the

place where the finished product will be used. Stained glass can be divided into two groups: (1) secular, and (2) sacred. Both groups can be divided into decorative or literary or decorative and literary. The artistic problems are divided as to ornamental, landscape, architectural, and figured. The technical problems concern (1) lead for decorative netting, (2) glass, (3) colors, and (4) coating colors. E.J.V.

Kappenberg stained glass windows. W. S. *Diamant*, **50** [6], 112–13 (1928).—A description of the celebrated collection of medieval stained glass windows from the Kappenberg Castle, now exhibited in the Museum in Frankfurt. E.J.V.

Glass painters of York. JOHN A. KNOWLES. *Diamant*, **50** [8], 168–70; [9], 190–91; [10], 214–16 (1928).—A historical discussion of the producers of stained glass in York in the 14th Century. Excerpts from manuscripts from that period are quoted to show the conditions extant then. Examples of the work of these men are cited. E.J.V.

Exhibition of stained glass. PAUL BIRR. *Diamant*, **50** [10], 207–209 (1928).—A description of stained glass produced in the Ernst Kraus Studios at Weimar, on exhibition in the National Museum in Weimar from March 1 to April 15, 1928. E.J.V.

History of faience. FR. LIPINSKI. *Keram. Rund.*, **36,** 91–94 (1928). H.I.

Recent discoveries in India: III. Buddhist art. JOHN MARSHALL. *Illust. London News*, **172,** 571 (1928).—A splendid array of bas-reliefs and a group of Buddhist monasteries, one containing a body relic of the Buddha himself, have been unearthed at Gummadiduru in the Kistna district of Madras. They date from the 3rd century A.D., and belong to the Amaravati school of sculpture, which is the most attractive of all the early Indian schools. A collection of 127 clay seals inscribed with the Buddhist creed in Nagari characters was found. Photographs show Greek influence in the detail of the reliefs. **IV. Temple at Paharpur with terra cotta plaques.** *Ibid.*, p. 685.—A temple at Paharpur, Bengal, is in process of excavation. The most striking feature of the monument is the plaques, running all round the basement of the temple in a single row, and in double rows round the circumambulatory passage. The majority of them are still *in situ*, but more than a thousand loose ones have been recovered from the débris. Illustrated. For abstracts of previous articles see *Ceram. Abs.*, **7** [6], 342 (1928). H.H.S.

Prehistoric remains of Cyprus. EINAR GJERSTAD. *Illust. London News*, **172,** 576–77 (1928).—A Swedish archaeological expedition has been making excavations in Cyprus. The tombs, plaques, and pottery found indicate that the Greeks colonized Cyprus before the end of the Mycenean period, brought their own tomb type with them, and there continued the Mycenean culture after it had disappeared from Greece. Illustrated. H.H.S.

Lord Nelson's dinner service. G. CALLENDER. *Illust. London News*, **172,** 808–809 (1928).—Nelson relics are on view to the public at Spinks' galleries in London. They include the dinner service (originally over 260 pieces) of old Worcester porcelain, presented to the admiral by the nation. Each piece was painted with a portrait of Lady Hamilton as Hope in varied attitudes on the seashore, with a ship at sea in the distance. Illustrated. H.H.S.

Study of oriental art. ANON. *Science*, **67,** 191 (1928).—A gift of $2,500,000 for the study of oriental art has been made by the estate of the late Charles M. Hall, of Oberlin, who devised a process for refining aluminum. An institution in Peking will be endowed under the direction of Harvard and Peking Universities. H.H.S.

Coloring agents in glass and glazes. HERBERT JACKSON. *Glass*, **4** [3], 97 (1927).—Some glassmaking secrets used by the Egyptians, lost for centuries, used by the Chinese, lost again, have been re-discovered in modern times. An instance of this is the brilliant

scarlet, nontransparent glass called sang de bœuf. Some of the early Saxon glasses had an orange-yellow color due to cuprous oxide in its yellow form. Cuprous oxide was also used by the Egyptians to produce a brilliant scarlet nontransparent glass while metallic copper dispersed through the glass in an extremely fine state of division gives a clear transparent red glass. Blues and greens were produced by cuprous oxide. Ferrous oxide was used to produce the same colors. Ferric oxide gave yellows, browns, and brownish reds. The glass composition was important. A.J.M.

Gold purple. II. C. G. FONTANA. *Atti accad. Lincei*, **6** [6], 231–35 (1927).—Since the proportion of SnO_2 adsorbent does not influence the size of dispersion of the Au particle the nature of the adsorbent was varied to determine the effect, precipitation with $Al(OH)_3Zr(OH)_4$ and $Th(OH)_4$ being tried. The solutions were prepared by the method of Kruyt and van Arkel-Adriani. To prepare the Au-Al_2O_3 mixture, the method of Zsigmondy was followed, the solutions containing 0.1 g. of Au and 6.2 g. of K alum respectively which gave a dry product containing 10.80% Au, 66.60% Al_2O_3, and 21.61% H_2O. Röntgenographic analysis showed this Au-Al_2O_3 purple to have a structure identical with the purple of Cassius (Au-SnO_2). The Au-ZrO_2 purple has not been described previously. Prepared from Au solution containing 0.1 g. of Au and concentrated $Zr(SO_4)_2$ (containing 2 g.) with NH_4OH and NH_4Cl to aid and complete the precipitation as before, it contained when dry 10.21% Au, 63.56% ZrO_2, and 25.37% H_2O. It had a structure like that of Au-SnO_2 and Au-ZrO_2. Prepared from solutions containing 0.12 g. of Au and 1.68 g. of Th $(NO_3)_4 \cdot 12H_2O$, respectively with NH_4OH and NH_4Cl, Au-ThO_2 purple contained 11.80% Au, 63.53% ThO_2 and 24.87% H_2O. Röntgenographic analysis gave negative results; so definite evidence was not obtained regarding the condition of the Au, perhaps because the Au is buried in the ThO_2. For Part I see *Ceram. Abs.*, **6** [9], 406 (1927). (*C. A.*)

Alchemical and colloidochemical considerations concerning gold. J. TRAUBE. *Chem.-Ztg.*, **52,** 3–4 (1928).—A modern alchemist in the Erzgebirge district claimed to get Au from mica schist in which chemists could detect none of the metal. T. describes his visits to the alchemist's laboratory, processes used, and results. Later the recovery of Pt (by others) under similar conditions was reported. Explanation is found in the behavior of colloidal metals toward the customary analytical processes, especially in the presence of hydrophyllic protective colloids. Similar conditions occur in Au dispersed throughout molten quartz. Upon the basis of experimental work in his own laboratory the author asserts that Au and Pt may be more widely disseminated in a colloidal condition than is ordinarily assumed. (*C. A.*)

The preparation of red-gold sols by using as reducing agents the extracts of fresh leaves and plants. E. IWASE. *Kolloid Zeit.*, **44,** 42–43 (1928).—The aqueous extract of fresh leaves of any plant is a suitable reducing agent for the preparation of Au sols. The color of the sols so obtained is not as vivid a red as that obtained by the Veimarn tartrate method. Camelia leaves, however, yield readily ruby-red sols. (*C. A.*)

Artificial ultramarines. II. Ultramarine blue rich in silica, and the allied silver. F. M. JAEGER AND F. A. VAN MELLE. *Verslag Akad. Wetenschappen Amsterdam*, **36,** 465–83 (1927).—A sample of Na ultramarine was purified, of composition $Na_6Al_4S_6O_{22}Si_2$ and its powder X-ray spectrogram was determined. The Na was then progressively replaced by Ag, and the spectrograms of the new substances taken. This changes the crystalline structure only slightly. The lattice remains the same, a_0 decreasing progressively from 9.06 A.U. for the Na_6 to 8.98 A.U. for the Ag_6 compound. Similar comparisons with ultramarines in which S is replaced by Se, and both Na and S are replaced by Ag and Se show that the substitution of Se for S does not affect the crystalline structure, but merely increases the dispersion, with a slight increase of a_0 to 9.10 A.U. These results suggest that the Na or Ag atoms are part of the basic structure of the

lattice, while the S and Se may be distributed merely statistically throughout the lattice. **III. Silver, alkali-silver, siliceous, mixed alkali, and butyl silver ultramarine.** *Ibid.*, 743–62.—The pure ultramarine blue of Guimet approximates a formula $Na_6Al_4Si_6O_{23}S_3$ or $Na_6Al_4Si_6O_{24}S_2$, of which the latter is preferable for symmetry reasons. Ag ultramarine prepared from it by $AgNO_3$ treatment is after careful purification probably $Ag_6Al_6Si_6O_{23}S_3$ (or O_{30}). In this Ag salt alkali can be reintroduced by refluxing with a 20-fold amount of alkali halide solution for 50 hrs. The substitution takes place incompletely. On heating 7 g. Ag salt with a 5-fold equivalent alkali halide +10 g. water in closed tubes at 130° for 50 hrs., mixtures were obtained and subjected to X-ray analysis: for LiCl dark violet-gray, 15.6% Ag, a_0=8.71 A.U.; for NaCl dull marine blue, 16.5% Ag, a_0=9.02 A.U.; for KCl, same color, 18.6% Ag, a_0=9.13 A.U.; for NH_4Cl olive green, 22.7% Ag, a_0=9.18 A.U.; for RbCl dull blue, 24.4% Ag, a_0=9.12 A.U. By heating for 50 hrs. at 160° with CsCl a chrome-green substance containing 8.54% Ag was obtained; with LiI dark violet, 2.8% Ag, a_0=8.67 A.U.; with NaI deep blue, 3.1% Ag; with KI dull dark blue, 4.3% Ag; with NH_4I dark green-brown, 12.3% Ag, a_0=9.34 A.U.; with RbI dull black-blue, 8.11% Ag, 7.08% S, a_0=9.28 A.U.; with CsI dull gray-blue, 11.2% Ag, a_0=9.11 A.U. Apparently iodides substitute more completely (AgI less sol.); for unequal molecular concentration substitution takes place more completely in concentrated solutions, the degree of substitution decreases from Li to Na, K, Rb, Cs with NH_4 close to K. No upper limit of $^2/_3$ substitution of Ag was found (Heumann) but merely an equilibrium reaction. As to the dimensions of the space lattice the a_0 values were determined from powder spectrograms; other a_0 values are given for 25 different mixed alkali and alkali-silver ultramarine. The a_0 value at first increases with increasing alkali atom size; it is for LiAg (11.5% Ag) 8.76 A.U.; for NaAg (8% Ag) 9.08 A.U., for KAg (11.24% Ag) 9.24 A.U.; it decreases again for RbAg (2.7% Ag) with 9.21 A.U. and CsAg (4.3% Ag) with 9.14 A.U., being 8.96 for pure Ag ultramarine. Different alkali metals cause differences in the relative intensities of the diffraction maxima. From Ag ultramarine+a 3-fold amount of butyl iodide was obtained after 50 hrs. at 130° a dull green substance with 38.6% Ag; after repeated treatment a greenish gray substance with 29.68% Ag: Bu_2Ag_4. By a third treatment a mixture with 8.7% Ag was made, with a_0=9.01 A.U. The spectrograms of all ultramarines made were completely analogous, no radical changes in space structure taking place. For preceding abstract see *Ceram. Abs.*, **6** [9], 406 (1927). (*C. A.*)

BOOKS

Graphic Design. W. G. RAFFÉ. Chapman & Hall, Ltd., London. 1928. Price 21*s*. H.H.S.

Art for 1928. Compiled by A. C. R. CARTER. London: Hutchinson & Co., 1928. Price 8*s* 6*d*. H.H.S.

Miniatures and Silhouettes. MAX VON BOEHN. Translated from the German by E. K. Walker. J. M. Dent & Sons, London. 1928. Price 15*s*. Chapters are devoted to the English, French, and German schools of miniature painting, while others treat of its application to china, porcelain, jewelry, fans, etc. Illustrated. Reviewed in *Illust. London News*, **172**, 628 (1928). H.H.S.

PATENTS

Plastic composition for modeling. MIKI SASAKAWA. U. S. 1,668,172, May 1, 1928. A plastic molding composition, formed by adding powder of lime carbonate and flower of sulphur to a soft fatlike substance produced by kneading a mixture of lime soap and a mineral grease, and kneading the whole well for the purpose herein set forth.

Mosaics. B. C. SCHOLZ. Brit. 269,697, Feb. 3, 1926. Mosaic tesserae and slabs are formed of potters' or china clay and are luster-glazed. (*C. A.*)

Cement, Lime, and Plaster

High-alumina slags in the blast furnace for the manufacture of alumina cement. T. L. JOSEPH. Bur. Mines, *Serial*, No. 2896, 7 pp. (1928).—The operation of a 6-ton blast furnace on a charge of bauxite, limestone, iron ore, and cast-iron turnings is described and the bearing which smelting such a charge has upon the production of alumina cement is pointed out. The experiment was conducted by the Bureau of Mines in coöperation with the Aluminum Co. of Amer. to determine whether the so-called Pedersen process can be applied to the blast furnace. This process consists of smelting a charge of bauxite, iron ore, and limestone, and results in two products. One is a slag containing about 50% of Al_2O_3 and is intended for use in manufacturing aluminum, and the other is iron low in sulphur. Complete details of the test are published in other reports. A short discussion of alumina cements is given. R.A.H.

Workability of Portland cement pastes. ANON. Bur. Stand., *Tech. News Bull.*, No. 132, p. 53 (1928).—The study of workability of Portland cement pastes has now included tests of 3 devices: the extrusion cylinder, the ball plasticimeter, and the capillary tube. The 3 methods have shown differences, in some cases very marked, in the behavior of various cements when tested in the form of neat cement pastes. The relative order, moreover, of the results is different for each of the 3 devices. This investigation must be continued to determine the extent to which the test method used influences the results obtained. It seems probable that the manner in which a cement is to be used should largely influence the choice of the method by which its workability is determined. R.A.H.

Strength of interlocking-rib tile walls. A. H. STANG, D. E. PARSONS, AND A. B. MCDANIEL. Bur. Stand., *Tech. Paper*, No. 366, 19 pp. (1928).—Eight walls, 1 x 6 x 9 ft., built of tile of a new design having interlocking ribs, were tested; 4 walls in compression, 3 walls under transverse loading, and one wall under transverse load before being tested in compression. Lime, cement-lime, cement, and no mortars were used in the horizontal joints. Spaces between the terminal ribs of the tiles in the walls were grouted. The strength of the walls under both vertical and transverse loads was affected by the workmanship and the mortar beds. The wall with cement-lime mortar beds sustained a maximum transverse load about $2^1/_2$ times that taken by the wall with lime mortar beds and higher than any other tile wall so far tested at the Bureau of Standards. Similarly, the compressive strength of the other cement-lime mortar bedded wall was about $2^1/_2$ times that of the other wall with lime mortar beds. R.A.H.

Manufacture of ammonium sulphate from gypsum and clay. P. BAUD. *Chem. and Ind.*, **47**, 419 (1928).—A process is now being tested on a large scale in which gypsum, clay, and ammonia solution are heated to 48–70°C in a current of CO_2. A 96% yield of 28% ammonium sulphate solution is claimed, and the slime of clay and $CaCO_3$ gives a good cement on burning at 1550–1600°C. H.H.S.

High-temperature whitewash. EDWIN P. ARTHUR, W. B. MITCHENER, AND JAMES R. WITHROW. *Ind. Eng. Chem.*, **19** [5], 591 (1927).—The following whitewash is recommended. A thin slurry is made by stirring finely ground lime into 5 gallons of water. Slowly add with stirring 0.5 pound of salt, 5 pounds of plaster of Paris, and $^1/_2$ pint of silicate of soda. Apply immediately with a paint brush to brickwork. R.J.P.

Formation and solution of calcium hydroxide crystals in Portland cement. JASPER O. DRAFFIN. *Ind. Eng. Chem.*, **20** [3], 311 (1928).—During some work in which the hydration of the compounds occurring in Portland cement was being studied it was observed that the calcium hydroxide which had at first been precipitated was slowly being dissolved. The compounds were placed on a glass slide, moistened with water, covered with a cover glass, and sealed with Canada balsam. In about 12 hours the calcium hydroxide crystals began to form and reached a maximum size in 2 or 3 weeks.

From this time many of the crystals commenced to redissolve. It was finally proved that the redissolving was due to attack on the soda-lime glass by the calcium hydroxide. Feldspars were mixed with cement but did not cause corrosion of the calcium hydroxide crystals. Soda-lime glass is more easily attacked than the soda-lime minerals. R.J.P.

Caustic value of lime; two filtration devices. W. M. SHAW, W. H. MACINTIRE, AND J. E. UNDERWOOD. *Ind. Eng. Chem.*, **20** [3], 312–14 (1928).—Two modified procedures and filtration devices adapted to the determination of the causticity of calcium sucrate solutions are proposed and the filtration procedure is compared to the modified Scaife procedure. R.J.P.

Effects of impurities upon the determination of causticity of limes by sugar and Scaife methods. W. M. SHAW AND W. H. MACINTIRE. *Ind. Eng. Chem.*, **20** [3], 315–19 (1928).—A study was made of the influence of the usual impurity components of caustic lime upon the accuracy of determinations of causticity values by the authors' modification of the sugar and modified Scaife method. The factors of magnesia, alone and in silicate combinations, interference of silica, neutral salt concentration of the titration, and the formation of ternary compounds are considered. R.J.P.

Effect of temperature and time of burning upon the properties of high calcium lime. K. W. RAY AND F. C. MATHERS. *Ind. Eng. Chem.*, **20** [4], 415–19 (1928).—The literature on this subject is reviewed. In the experimental work, samples of high calcium limestone were burned at temperatures varying from 900–1300°C (1652–2372°F) and for periods of 2–10 hours. The following properties of the lime obtained were measured, the rate of slaking, rate of settling, apparent density, time required for stiffening and plasticity. It was found that an increase in length of time in burning caused only a minor change in the properties of the lime. Active and quick slaking limes are produced at low temperatures while those burned at high temperatures are inactive and slow slaking. The optimum temperatures seem to be 1000–1100°C (1832–2012°F). The slowest settling hydrates are produced from lime burned at intermediate temperatures of 1100–1250°C (1832–2282°F). Plasticity of the lime putty decreases with increase in the burning temperature of the lime. The time required for stiffening of the slurries formed by slaking the quicklimes with excess water is greatest when quicklimes burned at intermediate temperatures are used. R.J.P.

Titrometric determination of calcium and magnesium carbonates in limestone. J. S. PIERCE, W. C. SETZER, AND A. M. PETER. *Ind. Eng. Chem.*, **20** [4], 436–37 (1928).—This method involves the use of trinitrobenzene as an indicator to show that the hydroxylion concentration has become great enough that all the magnesium has been precipitated. The sample is dissolved in standard acid and the excess is titrated with standard alkali using bromothymol blue as an indicator. This gives the amount of acid required to dissolve the carbonates. The magnesium hydroxide is precipitated with the standard alkali using trinitrobenzene as an indicator for the completion of the precipitation. From these two titrations the amount of calcium carbonate and the amount of magnesium carbonate can be calculated. R.J.P.

Determination of free lime in slags and cements. E. DIEPSCHLAG AND A. MATTING. *Centralblatt der Hütten und Walzwerke*, **31** [27], 363–66; [28], 377–80; [29], 294–98 (1927).—This subject is reviewed and the information presented in collected form. The presence of free lime and its causes are discussed. Many methods have been propounded for the determination of free lime, including methods with and without water as a solvent, with water in the presence of a weak acid (carbonic acid) according to special methods, with pure water only according to special methods, use of the microscopic methods of White, and use of the titration method with ammonium acetate according to Emley. All these methods are discussed in detail and it is concluded that the ammonium acetate titration method is the best. E.J.V.

Sensibility of thermobalance and analysis of hydrated lime by the balance. TAKAYUKI SOMIYA. *Jour. Soc. Chem. Ind., Japan*, **31** [3], 59–60B (1928).—Various improvements in the thermobalance invented by Honda have been introduced, so that its accuracy is equal to that of the analytical balance even above 1000°C. The hydrated lime is quantitatively analyzed by using this thermobalance. By weighing continuously the sample suspended from one end of the beam in an electric furnace and plotting curves, temperature against loss in weight, the percentage of $Ca(OH)_2$ is calculated from the amount of water given off at 400–500°C and that of $CaCO_3$ from the amount of CO_2 given off at 500–950°C. The amount of $Ca(OH)_2$ determined by this method was less than the theoretical amount by 2.1%, but that of $CaCO_3$ was determined without any loss. E.J.V.

Technology of gypsum plaster materials. I. OTTO FR. HONUS. *Rock Prod.*, **31** [4], 78–80 (1928).—The effect of calcination temperatures on properties of gypsum and the nature and utilization of anhydrous and dead-burned gypsum are discussed. **II.** *Ibid.*, [8], 83–86 (1928).—Properties effecting setting time of gypsum and empiric tests with various limes for strength are discussed. F.P.H.

Lime burning practice. III. VICTOR J. AZBE. *Rock Prod.*, **31** [6], 83–84 (1928).—The advantages and disadvantages of mixed-feed kilns are discussed. **IV.** *Ibid.*, [8], 87–89 (1928).—The Rudersdorf lime plant near Berlin, Germany is described. These observations are based on European and American practice. For previous articles of this series see *Ceram. Abs.*, **7** [5], 277 (1928). F.P.H.

Conditions influencing setting time of Portland cement. RICHARD K. MEADE. *Rock Prod.*, **31** [7], 58–64 (1928).—The following subjects are discussed: (1) substances which retard setting time, (2) calcium sulphate as a retarder, (3) occurrence of gypsum and active constitutents of gypsum, (4) conditions affecting retarders, (5) dehydration of gypsum, (6) effect of seasoning on setting time, (7) effect of heating on setting time, (8) effect of fineness of the retarder, (9) influence of chemical composition of clinker, (10) index of activity, (11) influence of alkalis, (12) effect of lime ratio and proper lime ratio, (13) desirability of uniform composition.

Effects of Variation in Lime Ratios on the Composition of Cements

Analysis	A	B	Ratio	A	B
Silica	22.86%	21.14%	Index of activity	3.06	3.06
Alumina	7.52	6.94	Lime ratio	1.86	2.07
Iron oxide	2.50	2.30	Probable Composition		
Lime	61.20	63.24	Tricalcium silicate	22.6	56.62
Magnesia	3.05	3.26	Dicalcium "	49.2	20.13
Sulphur trioxide	1.56	1.20	Tricalcium aluminate	19.9	18.74

In making the above calculations as to the probable composition of the two cements allowance has been made for the iron oxide, free lime, insoluble silica, magnesia, and sulphur trioxide. See *Concrete*, Mill Section, July and August, 1927. F.P.H.

Combating free lime in cement clinker with the petrographic microscope. L. N. BRYANT. *Rock Prod.*, **31** [7], 67 (1928).—B. describes White's test for free lime in fresh clinker after an extended period of observations of the various conditions occurring as to the fineness of the raw materials, the flux content, the temperature of burning, and the free lime content of the resulting clinker. A chart is given which is very useful in mill control. The method of using this chart is described. F.P.H.

Hydrated Portland cement as a colloid. ALFRED H. WHITE. *Rock Prod.*, **31** [9], 50–53 (1928).—A study is made of the products formed in the hydration process. This article is one chapter in the fifth "Colloid Symposium Monograph." Portland cement clinker on hydration forms products, some crystalline and some a stiff gel. This gel absorbs and gives up water with changing humidity of the air. A bar of neat cement may change in length more than 0.1% with alteration in atmospheric humidity.

The linear expansion when changed from dry air to water will be greater than this and may be as great as 0.5%. The gel retains this reversibility at atmospheric temperature for at least 20 years, and there is nothing to indicate that it may not continue indefinitely. The magnitude of the expansion increases with the number of alterations between the dry and the wet state, due to the progressive hydration of particles of unchanged clinker. F.P.H.

Analysis using a system of triangular coördinates. WALTER S., E. S., AND WM. S. ERNST. *Rock Prod.*, **31** [9], 54–57 (1928).—A practical method is given for obtaining information from the ordinary analysis of limestone, shale, or cement as to their availability for the manufacture of Portland cement. F.P.H.

Reducing man power in cement plants. HANS ENGEL. *Tonind. Ztg.*, **51** [90], 1637–38 (1927); *Rock Prod.*, **31** [7], 78–79 (1928). F.P.H.

Graphical representation of mortar material in tetrahedrons and in parallelograms. HANS KÜHL. *Tonind. Ztg.*, **51** [99], 1792–94 (1927).—A method of representing the composition of a 4-component system by the use of the tetrahedron is described. The use of a parallelogram for the same purpose is described. F.P.H.

Colloidal silica and magnesite. HEINRICH LUFTSCHITZ. *Tonind. Ztg.*, **51** [100], 1812–13 (1927).—For abstract see *Ceram. Abs.*, **7** [6], 346 (1928). F.P.H.

Making lime in ceramic bodies harmless. W. FISHER. *Tonind. Ztg.*, **51** [102], 1843–44 (1927).—The effect of free lime on the properties of ceramic bodies is discussed. Methods of eliminating the free lime sometimes found in bodies are discussed. F.P.H.

Pozzuolana of S. Paolo. A. GOLDBERG. *Tonind. Ztg.*, **52** [6], 103–104 (1928).—A report of an investigation of the composition and properties of volcanic ashes found near Rome that have been used as natural cements. F.P.H.

Testing structural lime. ANON. *Tonind. Ztg.*, **52** [14], 245–48 (1928); *Rock Prod.*, **31** [8], 112–13 (1928).—These instructions, published to promote further discussion, are tentative specifications and the result of revisions of the 1924 specifications in December, 1926, May, 1927 and December, 1927. (1) *General definition of lime:* Limes are mortar materials, produced by burning calcium carbonate in its various forms to a point below sintering. According to the extent of crumbling, produced by sprinkling the product with water, their composition and their ability to harden under water, limes are classified as follows: (*a*) white, (*b*) gray, (*c*) hydraulic, (*d*) cement (natural and artificial cement limes), and (*e*) Roman (Roman cements). (2) *Definitions:* Individual definitions of 5 groups are given. (3) *The commercial product and its properties:* Limes are delivered as follows: (*a*) unslaked lump lime (burned lime, "Brenntkalk"), (*b*) unslaked pulverized lime, (*c*) slaked lime, (*d*) pulverized slaked lime. Limes are tested to determine yield, fineness, soundness, and strength. (4) *Yield tests:* The yield is to be determined only for unslaked lime, whether as lump or pulverized lime: (*a*) *White lime:* 5 kg. lump lime slaked to a paste shall have an average yield not less than 12 liters lime paste. *Gray lump lime* slaked to a powder, shall have an average yield of not less than 12 liters lime powder (measured loose). (*b*) *Hydraulic lime:* 5 kg. hydraulic lump lime slaked to a powder, shall have an average yield not less than 10 liters lime powder (measured loose). (5) *Fineness:* The pulverized product shall leave a residue of not more than 10% on the standard No. 30 sieve (900 meshes per sq. cm., 0.20 mm. clear mesh opening). This residue shall be fine enough to pass the standard No. 10 sieve (100 meshes per sq. cm., 0.60 mm. clear mesh opening). (6) *Soundness:* all properly slaked limes are sound. In testing unslaked or improperly slaked lime, pats of neat lime are made, measuring about 8 cm. in diameter and 8–10 mm. thick at the center. These are cured in a tin box, whose cover is lined with felt and kept moist. Air curing is followed by immersion in water at room temperature for a period of 10

days. If no cracks or distortions are to be observed, the lime is then pronounced as sound. The pats are cured in air until they acquire sufficient hydraulic resistance. The latter is determined by placing a pat under water for 24 hours and observing possible deterioration. (7) *Strength:* Strength is determined on mortars composed of 1 part by weight lime and 3 parts by weight standard lime sand. The strengths shall have the following minimum values: *White lime* (air cured) tension = 2 kg. per sq. cm. at 28 days, compression = 6 kg. per sq. cm. at 28 days; *gray lime* (immersed at 21 days) tension = 2 kg. per sq. cm. at 28 days; *hydraulic lime* (immersed after 7 days) tension = 4 kg. per sq. cm. at 28 days, compression = 15 kg. per sq. cm. at 28 days. (*a*) In making standard mortars, the lime is slaked as specified above and sifted to specified fineness. (*b*) Lime and standard sand are mixed by hand in the proportions of 1:3 by weight for one minute and are then placed in a Steinbruck-Schmelzer mixer for 20 revolutions. (*c*) To make specimens, standard briquets and cubes for tension and compression tests respectively are made with 180 g. and 820 g. of the standard mortar. The mass is compacted by 150 blows of the Bohme hammer apparatus provided with the Martens clamping device. The excess mortar is struck off and the surface smoothed. The molds are removed from briquets after $^1/_2$ hour and are removed from cubes after 20 hours. Air-curved specimens shall be protected from air currents and cured at room temperature. Water-cured specimens shall be immersed with not more than 2 cm. water above the specimens. The water shall be changed every 14 days. (*d*) In testing, the breaking load is taken as the tensile strength of a briquet. The load shall be increased at a rate of 100 g. per second. The average of 5 tests shall be designated as the tensile strength. The breaking load determines the compressive strength. The load shall be increased at a rate of 10 kg. per sq. cm. per minute. The average of 5 tests shall be designated as the compressive strength of the specimen tested. Compression shall be applied on the side surfaces of the cubes. F.P.H.

New Italian cement standards. ANON. *Zement*, (1928); *Rock Prod.*, **31** [9], 82 (1928).—New specifications were issued November 11, 1927. (1) *Screen test:* 2% remaining upon 900-mesh (70-mesh Tyler) and 20% upon 4900-mesh (170-mesh, Tyler); (2) *specific gravity:* 3.00; (3) *setting time:* begins after 10 minutes, ends after 30 minutes for quick-setting cement; begins after 1 hour, finishes after 6–12 hours for normal-setting cement; (4) *strengths:* cements are divided into two grades: (1) quality (tensile strength after 7 days 285 lb./in.^{2}, after 28 days, 355 lb./in.^{2}; compressive strength after 7 days 3550 lb./in.^{2}, after 28 days 5670 lb./in.^{2}); (2) quality (tensile strength after 7 days 255 lb./in.^{2}, after 28 days 310 lb./in.^{2}, compressive strength after 7 days 2560 lb./in.^{2}, after 28 days 2550 lb./in.^{2}). F.P.H.

Formation of calcium hydrosilicates. FRITZ KLASSE. *Zement*, **17**, 2–9, 49–56 (1928); *Rock Prod.*, **31** [8], 113 (1928).—A foreword by Hans Kühl forms the introduction to a detailed report of tests made by K. The tests were limited to the formation of calcium hydrosilicates within a definitely fixed range of temperature and pressure conditions. No attempt was made to investigate the entire system of $CaO \cdot SiO \cdot H_2O$. He proceeded by making a substitution of a well-defined sodium silicate with a soluble calcium salt, thus obtaining equally well-defined calcium salts of the silicic acid used. When sodium silicate, produced by fusion of corresponding amounts of soda and quartz, is decomposed by means of concentrated acids, one obtains the hydrates forming the basis of the salts. Thus $2SiO_2 \cdot H_2O$ is derived from $Na_2Si_2O_5$ etc. The hydrous solutions of the above-named sodium silicates must contain a definite silica ion. A substitution with calcium salts results in the formation of calcium silicate in accordance with the following: $Na_2 \cdot SiO_3 + Ca(NO_3)_2 \rightarrow 2NaNO_3 + CaSiO_3$. This is the basic reaction used through the tests. When it takes place entirely in accordance with the direction indicated, the liquid must give a neutral reaction, provided the silicate formed

is insoluble and undergoes no change. All calcium hydrosilicates, however, are subject to a greater or lesser extent to hydrolysis, resulting in the formation of $Ca(OH)_2$. The alkalinity of the filtrate thus permits drawing certain conclusions on the nature of the precipitate. Another advantage of a substitution of two salts is that one of the reagents may be present in excess without producing the danger of more Ca-ions entering the reaction, than would be required for the formation of the expected hydrosilicates. A shaking device, arranged for 6 bottles, was used. Bottles of 500 cc. capacity were used in the tests, each receiving not more than 360 cc. of the suspension. Thorough agitation of the suspension was thus secured by providing sufficient height of drop during rotation. The purest materials were used throughout. K. summarizes his conclusions as follows: The tests, carried out with well-defined sodium silicates, used for the formation of corresponding calcium hydrosilicates, with the molecular ratios of $CaO:SiO_2 = 1:2$, 1:1, 2:1, have shown that the intermediate compound, the metasilicate, is the most stable, though it is subject to hydrolysis, like all hydrosilicates. The compound lower in lime than the metahydrosilicate, the expected disilicate, appears to be nonexistent; the tendency for lime absorption was observed. The hydrosilicate with higher lime content, the calcium orthohydrosilicate, shows on the contrary a strong tendency for lime liberation, so that a normal orthohydrosilicate was not obtained throughout these tests. The molecular ratio found in the tests, 1.50:1 and 1.76:1, has proved that the molecular ratio 1:1 of a metahydrosilicate may be exceeded in the direction of lime, and that all low-lime compounds tend to approach these high-lime ratios when acted upon by strong $Ca(OH)_2$ concentration. The results of tests permit us to assume as possible the existence of a calcium-orthohydrosilicate under the condition described. A pronounced tendency for the formation of a calcium hydrosilicate with the molecular ratio of 1.5:1, as manifested by strong hydrolysis, caused K. to conclude that the orthosilicate has a di-molecular structure. F.P.H.

Effect of low temperatures and freezing on high early strength Portland cement. A. GESSNER. *Zement*, **17**, 10–12 (1928); *Rock Prod.*, **31** [9], 82 (1928).—The tests were carried out by G. at Prague. The effect of freezing was studied on 7-cm. cubes of 1:3 mortar, exposed to frost action 4 hours after mixing and kept at a temperature of −6°C for 5 days. The mortar had not set during this time. Further 2 days' curing at room temperature resulted in a compressive strength of 53.5 kg. per sq. cm., showing that the setting properties of the cement were not permanently impaired. Other tests covered the effect of sodium chloride and frost action after initial curing of 24 hours in the moist closet and 24 hours in water. The latter tests showed great resistance of high early strength Portland cement after normal curing of 48 hours. Curing conditions were greatly varied in studying the effect of low temperatures. Immediate exposure to temperatures of 0 to −5°C resulted in great reductions of strength. The general conclusion was drawn that, while high early strength Portland cements, similar to other Portland cements, are subject to the effect of low temperatures and freezing, this effect is less pronounced due to the intensity of initial hardening. The strengths of high strength Portland cements exposed to frost action thus may still be above those of ordinary Portland cements. High early strength Portland cement is, therefore, particularly adapted for use under unfavorable temperature conditions. F.P.H.

New Polish cement standards. ANON. *Zement*, **17**, 180–85 (1928); *Rock Prod.*, **31** [9], 82 (1928).—The set should not begin before 40 minutes and should be complete in not more than 10 hours later. After 3 hours in the vapor bath the cement must be free of shrinkage cracks and warping. *Screen tests:* maximum of 2% residue on 900-mesh (70 Tyler) and 20% on 4900 (170 Tyler). *Chemical analysis:* loss in ignition 3.0% maximum, insoluble 1.5% maximum, SO_3 2.5, MgO 3.0; *specific gravity*, minimum of 3.3; *tensile strength*, minimum of 425 lb./in.^{2} for clean cement after 7 days in water,

for 1:3 mixture 215 lb./in.² after 7 days in water; after 28 days, 270 lb./in.²; *compressive strength*, 1:3 mixture after 7 days in water must be at least 2130 lb./in.²; after 28 days, 3550 lb./in.². F.P.H.

Gypsum research. P. P. BUDNIKOFF. *Zement*, **17**, 218–222 (1928); *Rock Prod.*, **31** [8], 112 (1928).—B. made tests of the effect of normal and molar acid solutions, their sodium salts, salts of univalent, bivalent, and trivalent metals, complex salts and bases on the rate of setting of plaster of Paris. The thermal effect was observed. Sulphuric, nitric, and hydrochloric acids, as well as $C_4H_6O_6$, are accelerators, whose catalytic effect decreases in the order in which they are named. Citric, acetic, formic, phosphoric, boric, and lactic acids are retarders, whose catalytic effect varies in the order named. Sodium salts were used to show the relation of the effect of the active acid anion in acid, natural, and weakly alkaline mediums. The 23 curves obtained showed that sodium salts of sulphuric, hydrochloric, nitric, hydrobromic, chloric, and thiosulphuric acids are beneficial to the setting process and may, therefore, be grouped with the positive catalyzers. The positive properties of the above-named salts decrease with increasing molecular weight. Sodium sulphate forms an exception. Sodium salts of sulphurous, citric, lactic, phosphoric, and acetic acids are retarders. The negative effect of carbonic acid is so pronounced that even a 10% solution of the salts of this acid produced no second temperature rise. The salts of univalent metals are strongly positive catalyzers. Their effect varies as follows: $(NH_4)_2SO_4 = KNO_3 = KCl = K_2SO_4 = (Li)_2SO_4 > NH_4Cl > AgNO_3$. The salts of bivalent metals are strong accelerators and are grouped as follows: $CdSO_4 > CuSO_4 > ZnSO_4 > MnSO_4 > NiSO_4 > FeSO_4 > MgSO_4 > Co(NO_3)_2$. The salts of earth alkali metals are grouped separately, as they contain a different acid anion and possess different concentrations. They are $CaCl_2 > BaCl_2 > SrCl_2$. The salts of trivalent metals in molar solutions are: $Al_2(SO_4)_3 > Cr_2(SO_4)_3 > Fe_2(SO_4)_3$. The standard solutions yield a variation: $Fe_2(SO_4)_3 > Cr_2(SO_4)_3 > Al_2(SO_4)_3$. The catalytic properities of complex salts vary as follows: $K_3Fe(CN)_6 > K_4Fe(CN)_6 > (NH_4)Al(SO_4)_2 > (NH_4)Fe(SO_4)_2$. The catalytic effect of alkalis is $KOH > NaOH > LiOH > NH_4OH$. The hydration of insoluble anhydrite was also studied. It was established that it can be brought about by the presence of alkalis, acids, natural and acid salts in small amounts. Most rapid hydration is produced in the presence of $NaHSO_4$. The finer the salts the stronger is the effect of the admixture. Acid salts do not require as great a fineness as alkalis or natural salts. All admixtures which produce hydration of insoluble anhydrite act as catalyzers. The process of setting cannot be explained entirely on the basis of hydration. Undoubtedly a change in crystalline formation takes place in time. F.P.H.

Japanese specifications for Portland cement. ANON. *Zement*, **17**, 244 (1928); *Rock Prod.*, **31** [9], 82 (1928).—(1) *Specific gravity:* at least 3.5. (2) *Screen tests:* not over 17% remaining upon 4900-mesh (170-mesh Tyler). (3) *Setting time:* to begin not before an hour and to end not later than 10 hours. (4) *Soundness test:* the cold water test and the boiling test ($1^1/_2$ hours) are specified. (5) *Tensile and compressive strength:* 1:3 mixture (by weight); tensile strength after 7 days 200 lb./in.², after 28 days 300 lb./in.²; compressive strength after 28 days 3000 lb./in². Clean cement: tensile strength after 7 days 570 lb./in.² (6) *Chemical analysis:* foreign materials not to exceed 2.5%; MgO 3.5%; SO_3 2.5%; loss on ignition, 4.0%. F.P.H.

The Dunstable Portland Cement Works. ANON. *Engineer*, **145**, 92–94, 120–23 (1928).—An illustrated account. (*C. A.*)

PATENTS

Process and apparatus for mixing quick-setting cementitious materials. GEORGE MILLER THOMSON. U. S. 1,660,242, Feb. 21, 1928. A process of mixing quick-setting cementitious materials, comprising controlling the time of normal setting by regulation

of the rate of agitation to effect hydration in accordance with variations in variable characteristics of the materials being mixed.

Cementitious material. HARRY E. BROOKBY AND CARLISLE K. ROOS. U. S. 1,668,548, May 8, 1928. A cementitious substance comprising ground calcium sulphate in the natural state, blended without calcination with sodium thiosulphate forming a mortar upon the addition of water.

Acid-proof cements. I. G. FARBENIND. A.-G. Brit. 267,396, March 25, 1926. A waterglass solution is mixed with a powder containing a compound of Si (other than SiO_2 or silicates) which when boiled for 2 hrs. with 25 times its weight of 15% NaOH solution is dissolved to the extent of at least 40%. Fluosilicates such as those of Na, K, Ca, and Al may be used. (*C. A.*)

Portland cement. AMMELUTHER WERKE BRAUNSCHWEIG DER MIAG MÜHLENBAU UND INDUSTRIE AKT.-GES. Brit. 284,294, March 21, 1928. A process for producing a white Portland cement from colored raw materials, for example from ferruginous materials, consists in adding small quantities of materials, such as metallic halogen compounds, phosphates or borates, which on heating give colorless melts with the coloring components of the raw materials. Reducing agents such as coke may also be added, or the material may be heated in a highly reducing zone. In an example, coke, flux, and borax are added to a mixture of ferruginous raw materials and after calcination under reducing conditions the clinkers are first coarsely ground and then finely ground, iron being removed magnetically after each grinding. The process may be applied to the raw materials separately before mixing.

Portland cement. AMMELUTHER WERKE BRAUNSCHWEIG DER MIAG MÜHLENBAU UND INDUSTRIE AKT.-GES. Brit. 284,295, March 21, 1928. Colored Portland cements are produced from colored raw materials, such as ferruginous materials, by adding thereto metallic pigments, such as oxides of chromium, nickel, cobalt, and copper, together with inorganic salts such as metallic halogen compounds, phosphates and borates adapted to combine with the pigments to form colored melts on heating. In the case of ferruginous materials, the calcination is effected under reducing conditions, the metallic iron being afterwards removed. In an example a green cement is produced by adding a flux, borax, coke, and chromium oxide to the raw materials.

Porous artificial stone. K. SCHENKEL. Brit. 285,470, April 12, 1928. A porous block is made by adding a hydrate cementing material to a gel suspended in water. To increase the porosity air may be injected. In an example, 2 parts of grain starch are brought to the gel state in 12 parts of water and 70 parts of water are added. Calcined gypsum, about 10%, is then added and the resulting mass is molded. The mass when set may be used in its original state as an absorbing medium in drying elements or in electric accumulators, or with the gel formation eliminated may be used for general purposes.

Aluminous cement. E. C. R. MARKS. Brit. 286,122, April 25, 1928. In the manufacture of aluminous cement in the rotary kiln the raw materials are fed to the kiln in the form of lumps, without preliminary grinding.

Enamels

Discussion on "Acid Resistant Enamels." CHARLES MUSIOL. *Bull. Amer. Ceram. Soc.*, **7** [5], 127–30 (1928).—Inaccuracies and errors in Malinovszky's paper are pointed out and some presumptions which are regarded as incorrect are mentioned. Malinovszky replies to the various criticisms with some detailed information on which his original paper was based. E.J.V.

Fusing porcelain enamel on iron and steel. F. W. MANKER. *Ceram. Age*, **11** [4], 131–33 (1928).—The modern stove manufacturing plant of today includes 3 major

sections: foundry, stamping, and finishing. Porcelain enamel has become the most popular of all stove finishes. M. describes the equipment and method of operation of a large stove manufacturing plant. The vitreous enamel department is divided into 3 sections: grinding, spraying, and baking. Enamel in the form of frit is received in the grinding section and reduced to the proper consistency in ball mills. Spraying is continuous, the spray booths being placed in a long row with a belt conveyer running through them. A new furnace installation represents a radical departure from recognized practice. Temperatures, heat gradients, and heating periods are controlled automatically. The drying and firing of ground and finish coats are carried out in one unit. A chain conveyer in the form of a closed loop is used in conjunction with a furnace 60 ft. long. A counterflow system enables heat given off by the hot work to be absorbed by the cold ware. A semimuffle divides the heating zone into two longitudinal chambers. One side of the conveyer is used in firing ground coats, the other for finish coats. Loss of heat through slots in the roof is prevented by balancing the interior and exterior pressure. Illustrated. A.E.R.W.

Value of nickel and chromium in gray cast iron. D. M. HOUSTON. *Canada Machinery*, **39**, 35 (1928).—Nickel, like Si, assists graphite formation and carbide decomposition, and therefore acts effectively to reduce chill and to eliminate hard spots, chilled edges, and mottled areas. In general, 1% Ni = 0.5% Si, but whereas Si is not effective in reducing chill beyond 3%, Ni can be added up to 10%. The Brinell hardness of cast iron containing Ni is as follows: Ni 0.0%, hardness 174; 0.67%, 217; 4.59%, 269; 9.0%, 350. Hardness is much more uniform over different sections of a casting with Ni than without. Better results can be obtained with a combination of Ni and Cr than with Ni alone. The effect of Cr is to refine the grain and markedly to increase chilling power. The content of Cr recommended is 0.1–0.5%. H.H.S.

Carborundum as a refractory material in the enamel industry. L. VIELHABER. *Feuerfest*, **4** [3], 33–34 (1928).—V. discusses the following subjects: (1) heat loss through the poor heat conductivity of fireclay muffles, (2) method of remedying this, (3) the use of Carborundum muffles, (4) their preparation and composition, (5) economy, and (6) practical experience with Carborundum muffles. F.P.H.

Glass

Annealing of hollow glassware. OSCAR KNAPP. *Sprechsaal*, **61** [3], 42–43; [4], 62–63; [5], 83–86 (1928).—The rules for practical annealing are as follows: (1) The lowest temperature at which strains are released should be attained, after which below it an equalization of strains is practically impossible. (2) The temperature at the beginning of annealing should be high, preferably as near the deformation temperature as possible. When a variety of large glasses of different wall thickness are annealed at the same time the initial temperature should be governed by the ware of smallest wall thickness. (3) The greater the speed of annealing, the shorter the time of annealing. In this case the largest glasses with the greatest wall thickness must be the controlling factor. (4) The annealing operations should be continuously controlled. R.A.H.

Making Hazel-Atlas glass. A. M. FORKNER. *Ceram. Age*, **11** [4], 138–40 (1928); from *Ind. Gas*, Feb. 1928.—After pointing out the properties and working qualities of glass that make it one of the most useful products of civilization, and the reasons why gas is used so extensively for melting glass, F. outlines the history of the development of glass in ancient times, the origin of some glass terms, and the history of the development of the Pittsburgh district and the Hazel-Atlas Glass Co. A.E.R.W.

Lowering packing costs with conveyers. L. C. ROCHE. *Ceram. Ind.*, **10** [5], 502–505 (1928).—A description is given of the installation by the Maryland Glass Corp.

of a superflexible conveyer system which has brought about a substantial reduction in labor required for packing and handling ware. F.P.H.

Fused quartz. FELIX SINGER. *Keramos*, **7** [4], T5 (1928).—The history of the development of fused quartz glass in America, England, and Germany is discussed. The properties of fused quartz are compared with those of glass, porcelain, and stoneware as follows:

	Glass	Quartz glass	Porcelain	Earthenware
Compressive strength (Kg./cm.^{2})	6000–12,600	19,800	5000	5830
Tensile strength (Kg./cm.^{2})	350	700	160–360	160
Bending strength (Kg./cm.^{2})		700	855	580
Torsional strength (Kg./cm.^{2})	900	300	500	200–300
Modulus of elasticity (Kg./mm.^{2})	4700–8000	7200	8000	4175
Dielectric constant	4–16	3–5	5–6	5–17

F.P.H.

Glass making of the past and present. FRANCIS C. FLINT. *Amer. Glass Rev.*, **47** [27], 15; [28], 15 (1928).—The history of glass is sketched from its first use, the making of crude ornaments, through vessels, tableware, bottles, and finally windows. Some of the formulas and methods employed by the ancients are still in use, some are just now being superseded, and some are being revived. The type of pot furnace used by the first glass makers is still in use in many parts of the U. S. Uniformity and quality of ware have come only in the past 30 years with the introduction of tested machinery to supplant hit-and-skip methods. The progress made in melting and blowing is described. The polariscope is mentioned as the most helpful instrument in the glass laboratory. The growth of science has taken glass manufacture out of the purely artistic status which it first held and placed it on the firm footing of an industry.

Effect of heat treatment on glasses. A. Q. TOOL AND D. B. LLOYD. *Amer. Glass Rev.*, **47** [30], 17 (1928).—For abstract see *Ceram. Abs.*, **7** [6], 351 (1928).

Auto-thermal fuelless leer introduced. ANON. *Amer. Glass Rev.*, **47** [32], 19 (1928); *Ceram. Ind.*, **10** [5], 552 (1928); *Glass Ind.*, **9** [5], 99–103 (1928); *Nat. Glass Budget*, **44** [1], 3 (1928).—A description is given of a new annealing leer introduced by the H. L. Dixon Co. It requires no fuel or other heating element, and prevents breakage of ware and imperfect annealing.

Testing nonscatterable glass. ANON. *Nat. Glass Budget*, **43** [51], 3 (1928).—A windshield made of nonscatterable glass of Johnston Glass Co., Hartford City, Ind., was tested by hurling a 2-pound rock against it from a distance of 10 feet. The glass crackled but there was no hole, and not a splinter was found either on the outside or within the car.

Technical innovations in glass production. E. G. HELLWART. *Diamant*, **49** [33], 650 (1927).—Innovations introduced in foreign countries include advances in the mechanical production of glass, new methods in the separation and resolution of hollow glass bodies and glass tubing, and improvements in the grinding of glasses. E.J.V.

Milk glass. W. H. *Diamant*, **49** [33], 653 (1927).—Various formulas used for the production of milk glass or opal glass are given. One given by O. Schott consists of 30 parts soda, 100 sodium fluoride, 375 silica or 100 soda, 85 sodium fluoride, 330 silica, and 75 red lead. In some cases feldspar, fluorspar, and barytes are used as opacifiers instead of cryolite. Batches used for production of colored opal glasses are also given. E.J.V.

Mirror production. ARTHUR LAURENT. *Diamant*, **49** [35], 685–86 (1927); **50** [3], 52; [4], 67–69; [6], 114–15; [7], 138–39; [12], 251–53 (1928).—The production of frosted glass is briefly taken up. The development of glasses, the melting furnaces, melting pots, mixtures, melting process, and casting are discussed. Various systems used in glass production are listed and briefly described. The use and principles of leers are explained. The polishing process, both hand and mechanical, is taken up in some detail. See also *Ceram. Abs.*, **7** [1], 17 (1928). E.J.V.

The plate glass process of Bicheroux. A. WENDLER. *Diamant*, **50** [1], *a–d*; [2], *b–d* (1928).—See also *Ceram. Abs.*, **7** [1], 16; [4], 222 (1928). E.J.V.

Protective coating of silvered mirrors. MAX ERMES. *Diamant*, **50** [2], 31–32 (1928).—A description of methods of protecting the silver coating on mirrors by applying shellac or some similar materials. For preceding abstracts see *Ceram. Abs.*, **7** [6], 351, 352 (1928). E.J.V.

Fürth mirror industry and its historical development. J. KARL HOHENBERGER. *Diamant*, **50** [5], 102; [6], 118–19; [7], 136–37 (1928).—A historical sketch of the mirror industry of the city of Fürth, which began in the 17th Century. E.J.V.

Mechanical window and table glass. A. F. *Diamant*, **50** [7], 142–43 (1928).—A discussion of the conditions in these two branches of the glass industry in Germany. E.J.V.

Glass technology school in Breslau. ANON. *Diamant*, **50** [11], 210–11 (1928).—A discussion of the establishment of the Silesian school of glass technology, and the curriculum to be offered. E.J.V.

Use of barite in soda lime flint glasses. D. J. MCSWINEY. *Glass Ind.*, **9** [5], 97–98 (1928).—Barium oxide has long been used as a constituent of special glasses and of tableware so that its fluxing power and its effect on the different properties of glass are well known. The barium oxide has been almost entirely introduced into glass batches in the form of the carbonate, though the sulphate has been used in a number of foreign batches. Barite (or barytes) the natural sulphate of barium is by far the cheapest source of barium oxide, being a mineral of wide distribution in nature. Although its use in foreign batches is old, until recently little or no attention has been paid in this country to the possibilities of its use in colorless soda lime glasses. The chief objections raised against the use of barytes in such glasses is the belief that in order to render effective as glass-forming materials any of the sulphates of the alkali or alkaline earth metals, reducing materials must be added to the batch, and the fact that barytes from most sources is too high in iron content to allow its use in any quantity in colorless glasses. During the past 18 months a large amount of barytes has been used in flint glass in amounts equivalent approximately to 1.2% barium oxide in the glass. The claims made for the use of barytes in soda lime glasses are (1) that it gives an easier melting batch, (2) that the glass refines more rapidly, (3) that it increases the brilliancy of the ware, and (4) that it improves the annealing and working properties of the glass and its resistance to weathering. Aside from lead oxide, barium oxide is the only cheap basic oxide which approaches the alkalis in fluxing power; the barium glasses, moreover, are very fluid at soda lime glass melting temperatures, and it is probably on this property that the use of barium sulphate as a scum preventative depends. Up to 1% barium oxide should not have a very marked effect on the temperature at which the glass can be melted, refined, and worked, but most users of barytes claim to be working their tanks at a lower temperature than before barytes was used. As barium glasses have a high index of refraction, barium oxide being second only to lead in increasing the refractive index, barium compounds have long been suggested and used in those glasses where brilliancy of the ware is of great importance and where the use of lead is undesirable because of its higher price, its tendency to blacken, etc. Again, 1% barium

oxide should not be sufficient to cause any great increase in the brilliancy of the glass, but there is no doubt that the use of this material has improved this property of the glass in many cases, and that the appearance of glasses made with barytes batches has been quite good. The apparent increase in brilliancy from the use of barytes probably results less from an increase in refractive index than from the oxidizing effect which barytes exerts during the melting, in which case, it probably acts like arsenic or niter on a selenium color, tending to prevent the development of a yellowish or brownish cast, and possibly to an increase in the fluidity of the glass tending to smooth out any irregularities of the surface caused by the use of rough molds. The effect of the addition of barytes on the working properties of the glass seems to vary with different batches and with the type of ware made; in some cases, better and quicker operation is claimed, while in other ware, particularly with heavy ware and glasses of low alumina content, and the usual ratio of soda, lime, and silica, the addition of barytes has necessitated some modification of blanks or has slowed operation slightly. The use of barytes in the batch in the above quantities does not appear to exert any pronounced effect on the annealing temperature or the resistance to weathering. Judging from the work done on glasses of high barium content, the addition of barytes should tend to lower the annealing temperature somewhat. The effect on the resistance to weathering will depend on what changes are made in the base batch on the addition of the barytes; if this addition is made at the expense of the silica, as is usually the case, a slight decrease (probably not enough to be noticeable) should be expected in the weathering resistance; while if the addition is made largely at the expense of the soda, an increase in this resistance should result, but not enough to counterbalance the loss of the favorable effect which the barytes otherwise would have on the melting and refining. While high barium glasses usually show a tendency to devitrify greater than that shown by soda lime glasses, the amounts of barytes at present used are insufficient to have any undesirable effect in this respect.

E.J.V.

Manufacture of flat glass. H. K. HITCHCOCK. *Glass Ind.*, **9** [5], 105–109 (1928).—Early methods of making sheet glass are discussed; the accepted methods and most recent developments in the industry are outlined giving references to the literature on the subject. The paper deals first with the primitive, hand-operated ways of producing flat glass by spinning, blowing, and casting; the development of the use of power-driven machinery in casting, blowing, and drawing; and finally with the development of the continuous method of casting from tanks and grinding and polishing, with a brief description of an improved method of casting from pots. E.J.V.

Weathering of glass and relative humidity. (Preliminary experiment.) KOZO TABATA. *Jour. Soc. Chem. Ind., Japan*, **31** [3], 60B (1928).—In the previous papers (Researches No. 179 (in English) and No. 189 (in Japanese) of the Electrotechnical Laboratory, Ministry of Communication, Tokyo, Japan) T. had described that the alkali present in glass combined to $R_2O \cdot 2SiO_2$, and the compounds $R_2O \cdot 2SiO_2$ were the exclusive agents acting with water vapor in the atmosphere. The results of the experiment show that (1) when the relative humidity of the atmosphere is below 70%, $Na_2O \cdot 2SiO_2$ tends to dry, (2) solution of $K_2O \cdot 2SiO_2$ remains in a syrupy state until about 50% relative humidity is attained, and (3) the vigorous action of weathering proceeds when relative humidity is above 85%. The temperature of the atmosphere during the experiment was 22–35°C. E.J.V.

Devitrification of glasses. V. Devitrification of flint glasses and their constitutions. KOZO TABATA. *Jour. Soc. Chem. Ind., Japan*, **31** [3], 60–61B (1928).—The phenomena of surface devitrification along assumed boundary lines of devitrification of flint glasses whose compositions having been $R_2O \cdot 0.5PbO \cdot ySiO_2$; $R_2O \cdot PbO \cdot ySiO_2$; and $R_2O \cdot ySiO_2$ were carefully observed. The heating conditions for crystal nucleus formation and for

crystal growths were assigned separately. The results showed that the crystals produced were SiO_2 and their degrees of devitrification (as assigned by T.) were found to be determined by the relative quantities of the components. It was concluded that flint glasses, except those very rich in PbO, were mutual solutions of $R_2O \cdot 2SiO_2$; $PbO \cdot 2SiO_2$; and SiO_2. **VI. A preliminary experiment on heating conditions for flint glasses.** *Ibid.*, 61–64B.—Samples taken from Marconi M.T.4 bulb glass were heated at 600, 625, 650, 675, 700, 750, 800, 850, and 900°C for 30–120 minutes. Radiotron U.V.199 and Cymotron 201A glass were also used for the experiments. The results are as follows: (1) the most vigorous spontaneous crystallization of Marconi M.T.4 glass occurred at about 700°C; (2) the crystal growth was rapid between 650–700°C; (3) above 750°C the forms of crystals were changed; (4) above 950°C the rate of crystal dissolution surpassed the rate of crystal production; (5) the different contents of PbO seemed to have no grave influence on the temperature at which the rate of spontaneous crystallization might be the greatest; (6) the crystals produced by heating were always the same, *i.e.*, SiO_2, for the above glasses having different compositions; (7) the temperature range of the maximum crystal production of flint glass was rather large. **VII. Devitrification of $R_2O \cdot CaO \cdot SiO_2$.** *Ibid.*, [4], 82–83B.—The phenomena of the devitrification of $R_2O \cdot 0.5CaO \cdot ySiO_2$ and $R_2O \cdot 0.8CaO \cdot ySiO_2$ are studied as described in the preceding reports. The conditions of heating for the most vigorous surface devitrification being of primary importance are determined experimentally. Results show that $R_2O \cdot CaO \cdot SiO_2$ consists of $R_2O \cdot 2SiO_2$, $CaO \cdot SiO_2$, and SiO_2, and also that 1 mol $CaO \cdot SiO_2$ dissolves 0.25 mol of SiO_2, or in other words the quantity of solvated molecule of silica to $CaO \cdot SiO_2$ to be 0.25, in the state of glassy mass. Some discussions are given on the papers by G. W. Morey and N. L. Bowen (*Jour. Soc. Glass Tech.*, **9**, 226(1925); *Ceram. Abs.*, **5** [2], 63(1926)) entitled "The System Sodium and Calcium Metasilicates-Silica." It is again proposed, that in treating devitrification of glass, it will be better to observe the phenomena of the surface devitrification. **VIII. Devitrification of $R_2O \cdot BaO \cdot SiO_2$.** *Ibid.*, 83–84B.—The same method of surface devitrification as conducted on $R_2O \cdot CaO \cdot SiO_2$ was applied to series of glasses whose compositions were $R_2O \cdot 0.5BaO \cdot ySiO_2$ and $R_2O \cdot 0.75BaO \cdot ySiO_2$. The crystallization of barium silicate from the glasses having 0.75BaO and the molar per cent of K_2O in alkalis being below 50%, has hindered the observation of the crystallization of silica by the degrees of devitrification as assigned by T. The same trouble has been met with in the glasses of 0.5BaO having K_2O less than 25% in alkalis. The other glasses give distinct silica crystals in order of the degrees of devitrification. From the results, T. gave the following constitution to the glasses: $R_2O \cdot 2SiO_2 + BaO \cdot SiO_2 + SiO_2$, and the quantity of silica dissolved per mol of $BaO \cdot SiO_2$ has been determined to be 0.5 mol. The boundary lines of devitrification were drawn according to the above results. **IX. Devitrification of $R_2O \cdot ZnO \cdot SiO_2$.** *Ibid.*, 84B.—The same experimental method of determining the surface devitrification described in the previous reports was applied to the glasses composed of $R_2O \cdot 0.5ZnO \cdot ySiO_2$; $R_2O \cdot 0.75ZnO \cdot ySiO_2$; $R_2O \cdot ZnO \cdot ySiO_2$; $R_2O \cdot 1.5ZnO \cdot ySiO_2$; and $R_2O \cdot 2.0ZnO \cdot ySiO_2$. The results give the following constitution to those glasses, under the same consideration: $R_2O \cdot 2SiO_2 + ZnO \cdot 2SiO_2 + SiO_2$. The quantity of SiO_2 to be dissolved in 1 mol of $ZnO \cdot 2SiO_2$ is nil. **X. Devitrification of $R_2O \cdot MgO \cdot SiO_2$.** *Ibid.*—The same experimental method of determining the surface devitrification by heat described in the previous reports has been applied to the glasses consisting of $R_2O \cdot MgO \cdot SiO_2$. In this case, however, differing from previous experiments, the boundary lines of devitrification were assumed for each series of glasses, $R_2O \cdot 0.5MgO \cdot ySiO_2$; $R_2O \cdot MgO \cdot ySiO_2$; $R_2O \cdot 1.5MgO \cdot ySiO_2$; and $R_2O \cdot 2.0MgO \cdot ySiO_2$ or in other words, MgO was assumed to exist in the form of $MgO \cdot 2SiO_2$ and no SiO_2 was dissolved in $MgO \cdot 2SiO_2$ molecules. The results of the experiments confirmed the assumption as true. The

following constitution is given to these glasses: $R_2O \cdot 2SiO_2 + MgO \cdot 2SiO_2 + SiO_2$. **XI. Heating conditions.** *Ibid.*, 85B.—In the previous experiments the phenomena of the devitrification of glass by heat were observed at the maximum rate of crystallization of silica in the glass. By the knowledge of the crystallization from supercooled liquid of solution, we see that the determination of the temperature of the maximum crystallization is one of the most important conditions for the experiment on the phenomena of the devitrification of glass. When, however, the phenomena are observed at the sharp edges or cicatrices and the degree of surface contraction is taken account of as one of the important conditions, the temperature and time of heating, *i.e.*, the heating conditions, are to be modified in a certain extent from the mere consideration of the relation between the temperature and super-saturation. Fortunately indeed, in the experiment, it was found possible to determine the temperatures of maximum rate of crystallization of β quartz by heating samples for about 60–120 minutes during which the sharpest edges round up slowly to become spherical. The points and methods of the experiments are considered. It is pointed out that the samples to be used in such experiments should have the constitution of excess silica in degrees of 0–4 of the devitrification as was proposed by T.; that the crystallization of silicates should not occur to an extent which will hinder the silica crystallization, at the assigned heating conditions, and also that samples which have undergone weathering, etc., which will alter the condition at the surface layer should not be used. **XII. Devitrification phenomena of glasses containing B_2O_3.** *Ibid.*, 86–87B.—Samples taken from new melts were examined according to T.'s method of surface devitrification.

Samples No.	Chemical composition	Boric compounds used	Degree of devitrification
(*a*)	1.0 Na_2O, 1.5 MgO, 0.5 B_2O_3, 5.5 SiO_2	Borax	above 4
(*b*)	0.5 Na_2O, 0.5 K_2O, 0.5 MgO, 0.5 PbO, 0.5 B_2O_3, 6.75 SiO_2	"	"
(*c*)	1.0 Na_2O, 1.0 PbO, 0.4 BaO, 0.25 B_2O_3, 5.5 SiO_2	"	3
(*d*)	1.0 Na_2O, 1.0 PbO, 0.4 BaO, 0.25 B_2O_3, 5.5 SiO_2	B_2O_3	"
(*e*)	0.5 Na_2O, 0.5 K_2O, 1.0 PbO, 0.4 BaO, 0.25 B_2O_3, 7.5 SiO_2	Borax	"
(*f*)	0.125 Na_2O, 0.875 K_2O, 1.0 PbO, 0.4 BaO, 0.25 B_2O_3, 8.5 SiO_2	B_2O_3	above 4
(*g*)	1.0 Na_2O, 2.0 MgO, 0.25 B_2O_3, 6.5 SiO_2	Borax	3
(*h*)	0.5 Na_2O, 0.5 K_2O, 2.0 MgO, 0.25 B_2O_3, 8.5 SiO_2	"	"
(*i*)	1.0 K_2O, 2.0 MgO, 0.25 B_2O_3, 10.5 SiO_2	B_2O_3	above 4
(*j*)	1.0 Na_2O, 2.0 ZnO, 0.25 B_2O_3, 6.5 SiO_2	Borax	3
(*k*)	0.5 Na_2O, 0.5 K_2O, 2.0 ZnO, 0.25 B_2O_3, 8.5 SiO_2	"	"
(*l*)	1.0 K_2O, 2.0 ZnO, 0.25 B_2O_3, 10.5 SiO_2	B_2O_3	above 4
(*m*)	1.0 Na_2O, 0.8 CaO, 0.25 B_2O_3, 3.25 SiO_2	Borax	3
(*n*)	0.5 Na_2O, 0.5 K_2O, 0.8 CaO, 0.25 B_2O_3, 5.25 SiO_2	"	"
(*o*)	1.0 K_2O, 0.8 CaO, 0.25 B_2O_3, 7.25 SiO_2	B_2O_3	above 4

Summary: (1) the crystals to be produced by appropriate heat treatment were SiO_2; (2) no differences were observed on using B_2O_3 or borax; (3) the degrees of devitrification have coincided with the assumption that the boric compounds present in the glasses combine to RBO_2; (4) the power of combination of Na_2O to B_2O_3 might surpass that of K_2O. When the quantity of Na_2O was deficient to combine with all the B_2O_3, K_2O combined to KBO_2 to effect the remarkable devitrification caused by SiO_2 crystallization; (5) such phenomena were difficult to explain by the assumption of the presence of compounds $Na_2O \cdot B_2O_3 \cdot SiO_2$ and $K_2O \cdot B_2O_3 \cdot SiO_2$ as described in the paper by W. E. S. Turner, etc. (*Jour. Soc. Glass. Tech.*, **9**, 395 (1925); **10**, 102 (1926); *Ceram. Abs.*, **5** [5], 145; [9], 270 (1926)); (6) T. regards this experiment as merely preliminary, for the compositions of glasses used are restricted, yet the combination of B_2O_3 to $NaBO_2$ and to KBO_2 might be regarded as true. E.J.V.

Standard specifications for glassware illumination fittings. Brit. Eng. Stand. Assn., *Pottery Gaz.*, **53** [610], 649 (1928).—Definitions of the following terms are given: bright

ness, translucent glassware, photometric integrator, and fitting. The specifications are listed as: general, dimensions, heat resistance, internal wiring, diffusing power, brightness, performance, and the requirements in regard to testing and selection are given. E.J.V.

Magnesium glass. H. KÜHL. *Pottery Gaz.*, **53** [611], 779 (1928).—K. has found that when 4–5% of magnesium is substituted for lime, the resistance of this glass against abrupt changes in temperature is increased. The magnesium was introduced in the form of white dolomite of known composition. E.J.V.

Action of barytes on glass. ANON. *Pottery Gaz.*, **53** [611], 779 (1928); reprinted from *La Ceramique*.—Barytes could often be substituted for lime and red lead in the manufacture of certain types of glass. As a substitute for lime it gives more fusible glass with a very fine luster. As a substitute for minium or red lead, it gives harder glass with a high refractive index, not coloring in a reductive flame, while the cost price is lower. By its use it is possible to obtain glasses of cheap quality for press working, cutting, and polishing. E.J.V.

Stained glass of the Renaissance period. WALTER BUTTERWORTH. *Pottery Gaz.*, **53** [611], 789–92 (1928).—The origin of glass and the changes in stained glass are touched on briefly. In 1134 "painted" windows were forbidden on the ground of luxury and extravagance. Important changes which occurred in the 14th Century are listed with the effects which they produced. The developments of the 15th Century and then the Renaissance period are traced. Examples of Renaissance glass in England are cited. Stained glass for secular buildings was used in increasing quantities, and many different effects obtained. The work of various artists is considered. E.J.V.

Manufacture and properties of glass and application in illumination engineering. S. ENGLISH. *Pottery Gaz.*, **53** [611], 800–803 (1928).—A decolorized glass has a general absorption throughout the spectrum and consequently must absorb more light than colored glass, which has only a selective absorption. Decolorizing materials are discussed. According to a French patent the incorporation of lead oxide up to 3% or titania up to 2% in a glass prevents discoloration of glass when exposed to sunlight. An American patent claims that the incorporation of antimony oxide in a glass is effective in preventing this discoloration. The methods used to produce the effect of daylight from an electric lamp are discussed. Three methods of diffusing light consist in the use of (1) opal glass, (2) etched or sand-blasted glass, and (3) glass with a prismatic or irregular surface. The breaking up and diffusion of a beam of light by a piece of opal glass depends on 3 factors: (1) the amount of material separated from the solution of the glass, (2) the size of the particles of this separated material, and (3) the difference in the refractive indices of the glass and the separated material. Success in producing opal glasses involves the control of (1) the amount of opalizing material in the glass when it is melted ready for working, which is not the same as the amount included in the raw materials; (2) the temperature of working and the rate of cooling during working; (3) the obtaining of a suitable viscosity in the glass at the temperature at which separation takes place in order to allow particles to grow to the desired size. The methods and materials used in producing the pearl lamp, or frosted glassware, are discussed in detail. The production of the third type having irregular surfaces of a comparatively coarse nature is also taken up. E.J.V.

Annealing of optical glass. A. LEBEDEFF. *Pottery Gaz.*, **53** [611], 812 (1928).—For abstract see *Ceram. Abs.*, **6** [1], 11 (1927). E.J.V.

Determining chemical value of glass. ANON. *Pottery Gaz.*, **53** [611], 812 (1928); reprinted from *La Ceramique*.—A piece of glass is drawn into the form of a thin tube and is kept for 12 hours in boiling water; it is then heated up to a point where it begins to soften. Under these conditions if the surface of the glass be examined it will be found

that the tube will remain transparent if the glass is of good quality, is covered with a network of fine lines visible under the microscope in the case of average quality glass, and that a glass of poor quality will be covered with a network of lines which are more or less crowded together according as to whether the quality of the glass is more or less inferior. E.J.V.

U. S. Tariff Commission Report on plate glass. ANON. *Glass*, **4** [2], 69 (1927).—The following points are covered in this report: classification of plate glass; methods of producing cast polished plate glass, rolled polished plate glass, cylinder and sheet glass (polished); proper classification for customs purposes; processes of production of plate glass as related to classification; sizes and thickness of plate glass. A.J.M.

Recent progress in the glass industry. W. E. S. TURNER. *Glass*, **4** [5], 186 (1927).—For abstract see *Ceram. Abs.*, **6** [7], 270 (1927). A.J.M.

Production costs of polished plate glass. ANON. *Glass*, **4** [5], 197 (1927).—Data and evidence as to costs, etc., gathered by the U. S. Tariff Commission, are presented. The following points are taken up: history of the investigation, uses of polished plate glass, production, organization, distribution for the U. S. and Europe (detailed data for Belgium), U. S. foreign trade. A.J.M.

Firing curves in glass plants. ANON. *Glass*, **4** [5], 209 (1927).—In general, the requirements of the industry involve the bringing of tank and pot furnaces up to working temperature, the arching of pots in a pot arch, the firing of green pottery to the biscuit stage, and the operation of the various subsidiary kilns. Great attention must be paid to the expansion of a furnace on heating. Adjustable tie rods should be provided and these carefully regulated. The firing should be conducted as uniformly and regularly as possible. Sudden, sharp rises should be avoided. The heating should not proceed quicker than the firing program allows and should not go slower because of the loss of time and money. Pyrometers should be used to regulate the temperature. Up to 800°C a base metal thermocouple may be used. When the maximum temperature is 1400° a rare metal couple can be used. From 800 to 1500° a radiation pyrometer may be used. In starting up gas-fired furnaces, direct fires are first applied by means of grates until 700–800° is attained. This process takes about a week. Gas is then turned into the furnace and the heating continues until the working temperature is reached. Care should be taken in putting gas into a furnace. In regenerative furnaces the gas is first allowed to pass through the flues and up the stack without entering the furnace. This clears the mains of air. The gas valve is reversed and gas passes into the furnace and is ignited. Very little gas pressure is used. The following precautions should be observed in putting gas into the furnace: (1) the producer should be first lit up and the fire started with timber and coke; (2) the fire bed should not be allowed to get too thick; (3) a few pounds of steam pressure should be put on the air blower; (4) the depth of the fire should be so arranged that, when the ash door is open, it is just above, and practically on a level with the top of the fire; (5) the gas should be in the furnace for some time before the door in the side of the producer is bricked up and closed. Attention should be paid to the quartz, tridymite, and cristobalite inversions which may cause difficulty. There is some question as to whether the blocks should be glazed or not when bringing a glass-tank furnace up to working heat. When the temperature is sufficiently high for this glass layer to fuse completely, it combines with the material of the refractory, forming a viscous layer of slag. This layer forms a protective coating against the molten alkali of the batch. The layer of slag, when broken open, consists of the following: (1) there is a thin layer of a glassy material, about 1 mm. in thickness; (2) then comes a thicker layer of a white porcelain-looki n material; (3) then the unchanged refractory. The white layer consists of a network of needles of sillimanite. If the blocks were heated above 1700°C, mullite would be

formed. The presence of fluxes greatly aids the formation of sillimanite which is of great importance because of its high resistance to corrosion by molten glass. Only a small amount of sillimanite is formed during the manufacture of the blocks. After the furnace is brought up to heat a soaking period of about 3 days should be given. The action of glazing the blocks is successful because the glass contains only about 2% of alumina while the refractory contains about 40%. Hence the glass abstracts alumina from the clay and with the silica which is in excess in the glass forms sillimanite. The layer of glaze also acts as a definite protective layer. If molten alkali comes in contact with an unglazed block, alumina and silica are dissolved from the block and it is rapidly corroded. The layer of glaze contains about as much alkali as the glass batch and hence the molten alkali is not nearly as important a factor as in the case of the unprotected block. Attack on tank blocks is fairly rapid for about a week and then is slower and more uniform. This retardation can be explained by the fact that the glass used for glazing has attained equilibrium with the tank block. The following methods are used for glazing: (1) A layer of cullet is charged on to the floor. After it becomes molten it is raked up against the side blocks by means of long iron tools. (2) The cullet is heaped up against the walls of the furnace to the top level of the flux blocks. When it melts it runs down and forms a glassy layer on the blocks. (3) The furnace may be filled with successive fillings of cullet and no batch added until the cullet has melted and filled the tank. A.J.M.

Firing curves in glass plants. ANON. *Glass*, **4** [6], 247 (1927).—It has been found that oxides such as those which exist in glass and clay combine at temperatures much below their fusion points. Decisive reaction and the formation of definite compounds have been noted at temperatures as low as 500°C. None of the individual oxides fuse at such a low temperature nor do any of the compounds which result from interaction. This is an important factor in the corrosion of tank blocks because the glass is in intimate contact with the blocks from almost the beginning of the firing period. At about 500° the glass begins to soften and at temperatures not much higher it penetrates the pores of the block and causes corrosion. As the temperature increases the glass penetrates further into the pores of the block and forms a vitreous honeycombed mass. The coefficients of expansion and contraction of the compounds formed by the interaction of glass and clay are quite different from those of the block and disintegration results. Fresh surfaces are then laid bare for attack and for the corrosion to actively proceed. To prevent this the following program is recommended in bringing up a tank furnace. The tank should be fired absolutely empty. After reaching working temperature the heat should be maintained for 3 days with the furnace still empty. This enables the blocks to acquire a texture very resistant to glass attack. After this, glass should be charged and melted and the block surfaces well glazed. The furnace should then be kept at maximum heat for another day to obtain the full benefit of the glaze. Then the filling can be commenced. In bringing up the glass pots in a pot arch the problem is more complicated because the pots are in the green state. The firing curve will be similar to that for the tank furnace. Great care must be taken at the dehydration period. The pot should be glazed after it has been placed in the furnace. It is very beneficial to fire glass pots to about 1400°C. This is not always done and pots are generally arched to only 1000–1100° at the most and sometimes not even this high. Opening the arch at the higher temperature to remove the pot is very trying to the men but this difficulty can be obviated by cooling the arch from 1400° to 1100° before removing the pot. An extra day should be taken for this procedure. A pot should be vitrified before filling and if this cannot be done in the arch the next best thing is to do it in the furnace. It should be kept for a day in the furnace while it is empty. Afterwards it can be glazed. Care should be taken not to expose the pots to too high

a temperature as squatting may result. When pots are placed in arches which are to run at high temperatures, they should be raised from the floor by being set on good quality fire brick with pure sand between the brick and the pot and between the brick and the floor. This will prevent adherence of the pot to the floor through fusion. Serious delays may be occasioned by this cause. The pot may be cracked because of chilling while it is being pried loose from the floor or the bottom may be damaged. In some cases green pots are placed directly in the furnace which is then used similarly to a pot arch and both the pots and furnace are brought up together. A grate is built in the case of a gas-fired furnace and the temperature is then gradually brought up, great care being taken in the early stages as in firing a pot arch. It should be possible to attain a temperature of 600°C with the fire box. The mouth of the fire box should be closed, air being allowed to enter under the fire bars. If excess air is allowed to enter the attainable temperature will be lowered. A thin fire bed should be maintained in the gas producer so as to give very little and not a very rich gas. The producer should be started up with coke and the firing with coke continued until the temperature of the furnace has reached 1000°C. Then the producer can be charged with coal. The object of charging with coke in the early stages is to produce a nonluminous flame which is fairly short and which will not dangerously affect the pots by fierce radiation or by licking round them as would the radiating, highly luminous, long flame of a coal-fired gas producer. The temperature of the furnace after gas has been put in should be advanced about 100°C per hour. Care must be taken to seal up holes in the walls through which cold air might enter and cause cracking of the pots. When the gas is first put in, it should not be allowed to issue very perceptibly through the eye above the level of the siege for about a day. The furnace should be held at working temperature for about a day to vitrify the pots. They should be filled with cullet for the first round and then regular founding may proceed.

A.J.M.

Condition of the Czechoslovakian glass industry. ANON. *Glass*, **4** [6], 262 (1927).—One-half of the 400 glass works in Czechoslovakia are now closed. There are 30 plate and sheet glass works of which 15 are in operation; 75 table glass works of which 43 are in operation; of 85 bottle works 40 are working; and of 210 hollow and decorative ware plants only 102 are in operation. The following reasons are given for the decline: (1) Exportation is becoming increasingly difficult due to the economic conditions of the purchasing countries and because the works in these countries are being developed by means of protective tariffs. (2) The Czechoslovakian government has not been able to make treaties with countries which would assist the glass industry. (3) There is an increase in the number of skilled workers leaving for France, Sweden, etc. (4) The prices of raw materials are too high. (5) The taxes on the industry and tariffs on the raw materials are too high. A.J.M.

Increased cost of raw materials for the glass industry in France. ANON. *Glass*, **4** [6], 262 (1927).—As compared with the prices in 1913 the prices of raw materials used in the glass industry in France have increased by the following percentages: carbonate of soda 500%, sand 500%, lime 300%, coal 400%, other materials 600%. A correspondent gives the following for the central part of the country: carbonate of soda 700%, sand 600%, lime 600%, coal 500%, antimony oxide 1400%. A.J.M.

Glass work practice. T. C. MOORSHEAD. *Glass*, **4** [7], 280 (1927).—Published in *Glass Ind.*, **8** [8], 185–89 (1927).—For abstract see *Ceram. Abs.*, **6** [10], 433 (1927).

A.J.M.

Russian glass industry. ANON. *Glass*, **4** [7], 299 (1927).—In 1913 there were 225 glass works in operation in Russia. Forty of these were in territory now severed from Russia. In 1920 only 48 works were in operation, the reason being attributed to lack of fuel and raw materials. Conditions have improved materially although the demand

still exceeds the supply. In 1923–24 there were 28,000 workers employed, in 1924–25 there were 43,000, and in 1925–26 the total had risen to 52,887. The total output in 1923–24 was 100,000 tons of glassware, in 1924–25 the output was 170,600 tons, and in 1925–26 the production was 234,503 tons. Russian imports in 1913 were 13,000 tons. In 1924–25 the figures were 1000 tons and in 1925–26 3000 tons were imported.

A.J.M.

Medieval processes of glass manufacture. J. A. KNOWLES. *Glass*, **4** [7], 303 (1927). —The ancients valued a perfectly white glass far more highly than colored glass and took great pains to insure the purity of the silica. Sand was obtained from places long distances away. Strabo (a century before Pliny) and Tacitus said that the Roman glassmakers brought their sand from the river Belus in Asia Minor. According to Pliny, the Romans purified their sand by giving it a preliminary roasting in which it was formed into a semivitrified mass with niter before receiving its final melting in the glass furnace. This process was evidently to cleanse the sand by carbonizing any vegetable impurities that it might contain. There is no documentary evidence to show where the medieval glass makers obtained their sand. The Belgian sands, which are noted for their purity, were undoubtedly used. In England, imported glass was valued far above the native product. In Venetian glass the freedom from any trace of greenish tint was due in large measure to the care with which the materials used as the source of silica were selected. Instead of sand they used stones which came from Pavia. Lime offered no difficulties since it is so easily obtained in almost all countries. It is a curious fact, however, that though it is almost an essential constituent of glass and analyses prove that it was used regularly, neither Theophilus in the 12th Century nor Hardiquer de Blancourt writing 500 years later make any mention of it whatever. The alkalis were not so easily procured. The soda was obtained by burning certain plants and lixiviating the ashes which were packed into barrels. The Arabs did a considerable trade in this product and called it "Kali." The Spaniards supplied the greater part of the soda required in western Europe in medieval times for glass and other industries. "Kelp" was another form of crude alkali from which a glass was made. This glass was much valued by glass painters because of the deep orange and red tint it was capable of receiving from the silver stain. It was this kelp glass which was so largely used by Peckitt and the 18th and early 19th Century glass painters to imitate by means of silver stain the copper ruby glass of earlier periods. The sources of potash were equally varied. It was obtained, especially in Germany, by burning logs and twigs of the beech tree and lixiviating the ashes in an iron pot. In France and certain parts of England the bracken or fougère growing on the moors was treated in a similar way and constituted a valuable source of potash. The most important requisite of the medieval glass maker, and one which in a large measure influenced the situation of the furnaces, was an abundant and easily procurable supply of fuel. The fuel consisted entirely of wood and had to be within easy reach since such large quantities of it were required to keep the furnaces going. Transportation was out of the question. The disappearance of the large forests, with which such large tracts were formerly covered, is in a large measure due to the iron and glass furnaces which consumed the timber as logs or charcoal.

A.J.M.

Analysis of opal glass. W. SINGLETON. *Chem. Trade Jour. and Chem. Engr.*, **82** [2129], iv (1928).—The constituents commonly occurring in commercial fluoride glasses are dealt with briefly, but more detailed consideration is given to the determination of boron, zirconium, tin, zinc, and arsenic. Silica is determined by the method of Berzelius, lead is separated as sulphide, converted to sulphate, and finally determined by the volumetric method, as molybdate. Iron oxide and alumina are separated by means of ammonia in slight excess, while lime is precipitated as oxalate, then ignited

and weighed finally as calcium sulphate. Magnesia was determined in the usual way, being weighed as the pyrophosphate. Cone and Cady, in the determination of zinc after separation as sulphide, find that fluorine present in a glass to the extent of some 5% does not interfere with the determination of boric oxide by the method of Wherry, as modified by J. D. Cauwood and T. E. Wilson. Zirconium is determined as pyrophosphate, according to the method described by W. F. Hillebrand. Arsenic is determined after decomposition of the glass by means of hydrofluoric acid. The solution of the glass is neutralized by ammonia, made acid with hydrochloric acid; then the arsenic is precipitated as sulphide. This is filtered, dissolved in caustic potash solution, and the arsenic finally determined volumetrically by titration against standard iodine solution. Fluorine is determined as calcium fluoride in the usual way, and no difficulties are met in the determination of tin by the usual gravimetric methods. L.P.C.

Ultra-violet ray transmission of colorless bottle glass. DAVID STARKIE AND W. E. S. TURNER. *Chem. Trade Jour. and Chem. Engr.*, **82** [2129], iv (1928).—Curves showing the intensity of the light transmitted in the different parts of the spectrum, from wave length 6500Å down to the limits in the ultra-violet, for eight commercial soda-lime-silica glasses of very similar composition, were prepared. Each glass showed a maximum transmission in the green or yellow regions, the percentage of light transmitted then falling off gradually in the violet, and near ultra-violet regions until a wave-length of about 3300Å was reached, when the percentage of light fell off very rapidly to the limit of transmission. The glass containing 0.05% Fe_2O_3 transmitted down as far as wave-length 2960Å. Four others each containing 0.07% Fe_2O_3 transmitted down to 2995Å, while the pale green glass with 0.18% Fe_2O_3 had its limit at wave-length 3175Å. All the glasses, with the exception of the green one, transmitted further down into the ultra-violet than the average window glass, the limit for this being at about wave-length 3100Å. As further illustrating the relation between transmission in the ultra-violet and iron oxide content, some pure glasses, of approximate composition 75% SiO_2, 10% CaO, 15% Na_2O, and small amounts of iron oxide, were tested. The iron oxide content and the limits of transmission were:

0.005	%	Fe_2O_3	transmission	to	2600Å
0.008	"	"	"	"	2660Å
0.015	"	"	"	"	2740Å

L.P.C.

Glass research and glass technology in 1927. WERNER MYLIUS. *Keram. Rund.*, **36,** 43–44, 86–88, 103–105, 182–86, 223–26 (1928).—The technical and scientific literature on glass in 1927 is reviewed at length. H.I.

German glass industry and Argentina. W. MOERING. *Keram. Rund.*, **36,** 94–95 (1928).—An increased interest of German technical men and financiers in building and operating glass plants in Argentina is urged. Glass manufacturing conditions in Argentina are reviewed briefly. H.I.

New processes and machines for glass manufacture. FR. LIPINSKI. *Keram. Rund.*, **36,** 142–46 (1928).—The Bicheroux and Ford processes for plate glass, the Danner process for tubing, the Fourcault process for sheet, the Owens machine for bottles, and the Westlake machine for lamp bulbs are described briefly. H.I.

Glass census. ANON. *Chem. and Ind.*, **47,** 419 (1928).—The value of glass bottles and jars in the 3rd (1924) census now published amounted to £5,315,000; illuminating glassware, £415,000; machinery glassware, £88,000; glass-tubing and rod, £148,000; other scientific glassware, £158,000; the total value being £13,260,000. In the former (1907) census, the total value, including Ireland (the last census is for Great Britain only), was £4,799,000. The average number of persons employed in the glass industry was 37,713 in 1924, and 31,229 in 1907. The net output per head was £217 in 1924. H.H.S.

Casting of large optical disk. ANON. *Science*, **67**, 263 (1928).—For abstract see *Ceram. Abs.*, **7** [4], 222 (1928). H.H.S.

PATENTS

Method of splice-laminating glass. LOUIS BARTELSTONE. U. S. 1,666,252, April 17, 1928. The method of splice-laminating glass which consists in forming an edge of each of two sheets of non-brittle material so that the edges are counterparts; placing the counterpart edges in abutting contact; placing these abutted sheets between plates of glass; holding the abutted sheets against relative movement, and applying pressure upon the glass plates to effect cohesion between the glass and the two intervening sheets.

Continuous glass-polishing means. ARCHIE W. PLATT. U. S. 1,666,347, April 17, 1928. In a machine of the class described, a conveyer for supporting plate glass and having a defined path of movement, a polishing unit having an endless path of movement forward and backward across the conveyer transverse to the conveyer movement with portions of its movement at the sides of the conveyer, means for causing the unit to traverse its path of movement, and means disposed at one side of the path of movement of the conveyer for reconditioning the polishing surface of the unit as it passes thereover.

Drawing sheet glass. HUGO N. DIEDERICHS. U. S. 1,667,145, April 24, 1928. Means for providing a deeper flow of conditioned glass from a producing tank to a sheet drawing means, comprising a metallic heat-absorbing body positioned in the path of flow of the surface strata of the molten glass, in combination with means for reheating the surface glass after passing under the heat-absorbing body.

Producing sheet glass. JOHN L. DRAKE. U. S. 1,667,146, April 24, 1928. The process of producing polished sheet glass, consisting in grinding both surfaces of a sheet of glass, passing the ground sheet through a heating chamber, fire-polishing one side of the sheet, turning it over and fire-polishing the other side, and cooling.

Glass-handling apparatus. RAYMOND G. BACHELLER. U. S. 1,667,714, May 1, 1928. Apparatus for handling glassware, comprising an inclined chute pivotally supported adjacent to its upper end, a receiving rack extending transversely of the chute and mounted adjacent to the lower end thereof, and means for swinging the last-named end of the chute longitudinally of the rack to deliver a series of articles thereto.

Glassworking machine. NICKLAS FRANZEN. U. S. 1,668,200, May 1, 1928. In a glassworking machine, the combination of a suitable support for molten glass, a forming roll and wire working rolls in operative relation to the molten glass, means for adjusting the rolls simultaneously, and means for raising and lowering the wire working rolls out of and into contact with the glass.

Manufacturing glass corner strips. WILLIAM UHL. U. S. 1,668,576, May 8, 1928. The process of manufacturing corner and base strips of glass consisting of rolling a sheet of glass in a flat blank, applying a die to the surface thereof while in a plastic state and pressing it therein to form a plurality of parallel ridges and depressions, said depressions having the desired concave curvature in cross-section of the finished strip, and cutting the glass between the ridges formed thereon and adjacent recesses at the thinnest part thereof, whereby the glass will be formed into a plurality of strips having a surface running longitudinally thereof concave in cross-section and of the desired curvature.

Glass melting and refining tank. GILBERT E. STICKLER. U. S. 1,668,700, May 8, 1928. A regenerative glass melting and refining tank including a melting section of circular form in plan provided with side sets of opposed radial regenerator ports, and a refining section having a rear receiving end portion of rounded form in plan provided with side opposed regenerator ports, there being a passage connecting the sections, the melting section having a rear batch supply opening, and the refining section having a forward glass delivery end.

Apparatus for shaping glassware. DAVID P. WEAVER. U. S. 1,668,993, May 8, 1928. Apparatus for shaping a parison for wide mouth ware comprising a mold, an external mouth finishing member associated therewith, an internal mouth finishing member of boxlike structure mounted for vertical movement in the mold, a plate of hollow structure mounted for vertical movement in the internal member, means for compacting a charge of molten glass in the mold and between the external and internal members to form the finish of the parison and an initial blow opening therein, means for independently raising and lowering the internal member and the plate, means for supplying counter-blowing air to the mold through the internal member, and means for causing a circulation of a cooling medium in the plate.

Laminated glass. FRANK FRASER. U. S. 1,669,044, May 8, 1928. (1) As a new article of manufacture, a sheet of laminated glass including a sheet of nonbrittle material impregnated with castor oil. (2) The process of producing laminated glass consisting in producing a sheet of nonbrittle material containing a relatively large amount of oil, treating the sheet to bring a film of oil to the surface thereof, and then combining the same with a sheet of glass.

Glass-delivery apparatus. RICHARD LA FRANCE. U. S. 1,669,475, May 15, 1928. Glass delivery apparatus comprising a revolving tank and means for feeding molten material to substantially the center of the tank.

Sheet glass. EDWARD H. HOBBIE. U. S. 1,669,663, May 15, 1928. A sheet of glass for distributing rays of light passing therethrough in such directions that substantially all rays of light passing through the sheet of glass are directed so as to have a vertical component of direction when the sheet of glass is placed in a vertical plane, and having a plain surface through which rays of light pass when entering; a figured surface having a multiplicity of pyramid configurations produced by intersecting grooves and imaginary ridges defining triangular planes and vertices respectively of the pyramid configurations, all grooves and imaginary ridges running obliquely to at least one edge of the sheet of glass whereby the side intersections of the triangular planes of the pyramid configurations lie in planes perpendicular to at least one edge of the sheet of glass.

Method of and apparatus for melting glass. EDWARD J. SCHNEIDER. U. S. 1,669,676, May 15, 1928. In glassmaking apparatus, a tank furnace having a refining chamber at one end segregated from the melting end sufficiently so that the glass in the refining chamber may be kept cooler than proper working temperature, there being firing ports only in the end of the tank opposite the refining end, a working chamber in communication with the refining chamber, and means to raise the temperature of the glass in the working chamber.

Windshield glass. HUGO L. KLEIN. U. S. 1,669,874, May 15, 1928. A vehicle window composed of reinforced glass, having nonreticulated embedded parallel strands of wire arranged horizontally.

Glass. BERNARD LONG. U. S. 1,669,908, May 15, 1928. A soda lime glass having metallic elements therein which is affected by waves of short lengths and containing not over 3% of oxide of lead.

Glass furnace and leer. JULIUS H. O. BUNGE. U. S. 1,669,968, May 15, 1928. In combination, a glass furnace having a partition wall for dividing the furnace into a glass melting chamber and a glass refining chamber, a burner for heating the furnace, means for conducting air through the furnace wall to preheat the air and for thereafter delivering the air to the burner, and means for causing the gases of combustion from the burner to circulate through the furnace chambers.

Method and apparatus for use in the manufacture of glassware. LÉON JEAN BROCHE. U. S. 1,670,058, May 15, 1928. In apparatus for the manufacture of glass products, a feeder for molten glass comprising a rotary pick-up member arranged on an

axis inclined to the surface of the bath of molten glass and dipping at its lower periphery into the latter, the pick-up member being apertured toward its axis and delivering glass from its upper inclined surface through the aperture in the form of an annulus, in combination with a tubular axial extension of the rotary pick-up member through which the annular discharge from the pick-up member passes in the form of a fluid cylinder, together with means at the discharge end of the tubular extension for establishing an intermittent feed of the glass to associated apparatus.

Continuous tank furnace. WILLIAM K. BROWNLEE. U. S. 1,670,098, May 15, 1928. In glassworking apparatus, a tank for the molten glass, comprising an inner wall of refractory tank blocks, an intermediate wall of fire brick, and an outer wall of insulating material.

Method and apparatus for producing pressed sheet glass. FRANK FRASER. U. S. 1,670,110, May 15, 1928. A mold for forming finished plate glass formed from a non-corrosive metal alloy comprising a body portion, a removable member arranged within the mold and supported by the bottom thereof, and a pivoted side wall carried by the mold to permit the removal of the plate.

Drawing sheet glass. ENOCH T. FERNGREN. U. S. 1,670,246, May 15, 1928. (1) In sheet glass apparatus, the combination with a container for the pool of molten glass from which the sheet is drawn, of means for retarding the flow of the glass flowing toward the point of draw, including a raised portion formed in the floor of the container, and having two inclined sides and an arched upper edge. (2) The combination with a source of molten glass, and a sheet glass drawing mechanism, of a container for the pool of molten glass from which the sheet is drawn, the container being in open communication at one end with the source of molten glass and closed at the other end, the container comprising a main central passage wherein surface glass flows directly to one side of the sheet, the main central passage being provided with means for retarding the central flow of substratum glass, and a pair of side passages through which glass flows to the closed end of the container to supply the other side of the sheet.

Plurality sheet drawing apparatus. ENOCH T. FERNGREN. U. S. 1,670,247, May 15, 1928. In sheet glass apparatus, a tank furnace, a tank communicating therewith and having a mass of molten glass therein, and means for drawing a plurality of sheets therefrom, each sheet being drawn from a different stratum of glass.

Sheet-glass-drawing apparatus. ENOCH T. FERNGREN. U. S. 1,670,248, May 15, 1928. In sheet glass drawing apparatus, a plurality of lip tiles covering a mass of molten glass, and an insulating material having a greater thickness at the outer edges of the lip tiles than at their centers, covering the upper portion thereof.

Apparatus for feeding charges of molten glass. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD., AND W. J. MILLER. Brit. 267,979, March 20, 1926. (*C. A.*)

Heavy Clay Products

Bibliography of plasticity. PAUL J. SLEGEL. *Bull. Amer. Ceram. Soc.*, **7** [5], 130–36 (1928).—A bibliography of plasticity covering the literature from 1895 to date.

E.J.V.

Hollow tile manufacturing. III. Getting the correct die. ERNEST W. KNAPP. *Brick Clay Rec.*, **72** [9], 646–50 (1928).—Correct die is a principal factor in the success or failure of hollow tile, fireproofing, and other clay products. K. presents various experiments with the different types of dies and gives much valuable information. Three types of dies are studied: the ordinary dry die, the corner lubricated die, and the full lubricated die. **IV. Drying and firing.** *Ibid.*, 706–12.—Drying is a most important phase in manufacturing clay products, often determining the quality of the product, and is a subject on which there is little practical information. This, the last

of a series of papers on efficient clay plant operation, covers the subject of drying very completely. Various types of kilns used in firing tile at different times are discussed. An open top semicontinuous top-fired kiln for hollow tile, which has proved very economical, is described. For abstracts of preceding articles see *Ceram. Abs.*, **7** [6], 365, 366 (1928). E.J.V.

The home of Ristokrat brick. ANON. *Clay-Worker*, **89** [5], 371–75 (1928); *Brick Clay Rec.*, **72** [9], 626–37 (1928).—A description of the well-equipped plant of the L. E. Rodgers Clay Products Co., recently completed at Lowell, Illinois, where a high grade face brick is made. E.J.V.

Factory design and equipment. XIV. T. W. GARVE. *Clay-Worker*, **89** [5], 380–81 (1928).—A discussion of methods of handling both the more or less avoidable waste and the necessary waste in a heavy clay plant. Mechanical devices for conveying the waste material to where it may be re-used or entirely disposed of are described. For preceding abstracts see *Ceram. Abs.*, **7** [6], 386 (1928). E.J.V.

Brick and brickmaking in the U. S. VIII. GEORGE M. FISKE. *Clay-Worker*, **89** [5], 388–92 (1928).—A description of the development of the Fiske brickmaking system worked out in 1902, in which mechanical handling of the brick had a very prominent part. For preceding abstracts see *Ceram. Abs.*, **7** [6], 367 (1928). E.J.V.

Yellow scum on bricks. ANON. *Brit. Clayworker*, **37** [432], 15 (1928).—Yellow scum is somewhat rare. One form of it has been traced to soluble vanadium salts in the clay. Another form was found to be due to the use of kiln gases for drying the brick in a tunnel drier in which the waste gases came in direct contact with the goods. The brick being cool and damp, the hot gases tended to condense and the acids deposited thereby on the brick, combined with a small proportion of lime in the clay, formed a scum which ordinarily would have been white, but instead was colored yellow by iron compounds dissolved from the clay by the acid condensed from the kiln gases. Where brick of good color are required it is a mistake to allow them to come into contact with kiln gases until the brick are at such a temperature that no condensation can occur on them. R.A.H.

Fire resistance of sand-lime and concrete brick walls. ANON. Bur. Stand., *Tech. News Bull.*, No. 132, pp. 50–52 (1928).—A series of fire tests of brick walls was completed at the Bureau. The object was to determine the fire protection, strength, and stability under fire conditions of this construction. A description of the materials and test specimens and method of testing same are included together with their stability and load carrying ability, fire effects on brick and masonry, and fire resistance classification. R.A.H.

Control of clay slips by use of electrolytes. ANON. Bur. Stand., *Tech. News Bull.*, No. 132, p. 54 (1928).—A study is being made of protective colloid action in the casting of clay slips. Tannic acid and peat have been used to date. The addition of small amounts of these materials to slips containing little or no carbonaceous matter has been found to decrease the amount of water necessary to make up the slips and to increase markedly the cross-breaking strength of inch bars from such slips. R.A.H.

Preparation of silica brick. PAUL MÜLLER. *Tonind. Ztg.*, **52** [3], 35–38 (1928).—Methods of preparing silica brick in Germany are described. The sources of quartzite used for making brick in the U. S. and Germany and the plant equipment used in the various processes are considered. F.P.H.

Separation of solid material from liquids with special reference to clay material. C. R. PLATZMANN. *Tonind. Ztg.*, **52** [5], 74–77 (1928).—Various types of filter presses are discussed. The colloid filter, the centrifugal filter, and the vacuum filter are described, and their applications to clay purification are shown. F.P.H.

Preparing floor-tile bodies. OTTO MUCKER. *Tonind. Ztg.*, **52** [7], 115–17 (1928).—A description is given of the wet process, the semidry process, and the dry process of making floor-tile bodies. The types of equipment and plant layouts used in these various processes are illustrated. F.P.H.

Hollow tile in America. HERBERT V. KAEPPEL. *Tonind. Ztg.*, **52** [8], 127–31 (1928).—A description is given of the methods and types of equipment used in America to manufacture hollow tile. F.P.H.

Standardization of brick superstructure. K. WERNER SCHULZE. *Tonind. Ztg.*, **52** [9], 147–49; [10], 169–72 (1928).—Types of building construction used in Germany are discussed. F.P.H.

Determination of drying behavior of clay. L. ZWILINJOW. *Ukr. Silikati*, [4], 149–50 (1927); *Feuerfest*, **4** [3], 47 (1928). F.P.H.

Western Clay Products Manufacturers Association. W. G. WORCESTER. *Clay Prod. News*, **1** [1], 2 (1928).—The meeting was held at the Ceramic Dept. of the Univ. of Saskatchewan, March 28–29. The officers elected for the coming year were E. H. Sellhorn of Redcliff, Alta., president, and R. C. Hargrave of Redcliff, secretary-treasurer. H.H.S.

Bubbles, flakes, cracks, etc., in stoneware. L. TONTSCHEFF. *Keram. Rund.*, **36**, 65–66 (1928).—Defects in stoneware such as bubbles, flakes, and cracks are frequently caused by (1) improper preparation of the body, (2) bitumeniferous raw materials, (3) poor firing methods. Wet clay should not be mixed with dry nonplastics. The best method is to dry the raw materials, then mix thoroughly and finally add the water. Most defects occur in the firing, especially in the watersmoking and final periods. Temperature increases during these periods must be gradual and regular. Bubbles in bitumeniferous bodies are almost unavoidable during watersmoking. In bodies containing large limestone grains the increase in temperature in the final period must be very slow to avoid bubbles. The use of temperature measuring apparatus during firing is advised. H.I.

BOOK

Plastic Condition of Materials. A. NADAI. Berlin, Julius Springer, 1927. 171 pp. Illustrated. Price 15 RM. Reviewed in *Min. and Met.*, **9** [256], 203 (1928).—N. describes the behavior of structural materials in the plastic state, in the light of his own researches at Göttingen, as well as those of other investigators. He brings together the information at present available for developing laws upon which the behavior of metals under stress may be predicted and on the phenomena attending the plastic flow of solids. F.P.H.

PATENTS

Metallurgical briquet and its use. WILLIAM B. RUNYAN. U. S. 1,666,312, April 17, 1928. A briquet free from an admixture of metallic ore comprising ground coke, a silicon sand, and lime, the sand and lime being present in about equal parts and in sufficient quantities to hold the carbonaceous matter together.

Wall construction. EDWARD H. KLEINFELDT. U. S. 1,667,160, April 24, 1928. A wall construction including a plurality of courses of building blocks, each comprising laterally spaced portions joined by integral webs and defining air circulation spaces between the portions, each block having a vertical tongue at one end and a vertical groove at the opposite end for interengagement with similar elements formed on adjacent blocks, the upper face of each block portion having a longitudinal groove for the reception of a bonding material and the lower face of each block portion having a longitudinal tongue of lesser depth than the groove to afford a space for accommodating the bonding material, the tongues and grooves of adjacent superimposed blocks adapted to interfit,

the upper portion of the tongues being of a size to snugly fit the grooves for insuring proper alignment of the outer surfaces of the blocks.

Brick pallet setting installation. JOHN B. MAYONE. U. S. 1,668,118, May 1, 1928. In a brick making machine of the type including an inverter, having correlated pallet and mold rests and transmission means for relatively moving the rests; the combination of automatic pallet setting means comprising a pallet feeder, the pallet rest being coordinated with the feeder to move past the latter in its approach toward the mold rest, thereby to engage and to pick up the pallet.

Wall construction material. JAMES HENRY PRESTON. U. S. 1,669,019, May 8, 1928. A wall construction comprising spaced courses of superimposed load sustaining blocks, with the blocks of each course arranged in end to end relation, the base portion of each block being extended inwardly and upwardly to provide a hooked ledge and a plurality of relatively spaced tie blocks inserted between the courses, each tie block being formed with integral extensions adapted to interlock with the hooked ledges of the load sustaining blocks of the courses.

Building block. RAOUL STEPPE. U. S. 1,670,286, May 15, 1928. A building structure of the character described, comprising a plurality of blocks each including a body provided along one longitudinal contacting edge with a groove and with vertical openings arranged in staggered relation on opposite sides of the groove, longitudinal and vertical reinforcing wires receivable in the grooves and openings of adjacent blocks, cementitious binding material for anchoring the rods in the blocks and the blocks together, substantially as and for the purposes set forth.

Refractories

Future progress in the field of refractories. STUART M. PHELPS. Amer. Refrac. Inst., *Bull.*, No. 21, March (1928).—Progress has resulted in all branches of industry as a result of the coördination of knowledge and experience in a systematic or scientific manner. Producers and consumers coöperate to their mutual interests in extending the usefulness of commodities. There has not been developed, however, the coöperation between the manufacturer and user of refractories to effect the progress that is to be desired in this field. The whole problem of advancement in the utility of refractories is of such a complicated and obscure nature that at times it appears hopeless. The manufacturer or user cannot solve the problem alone and it is only through the closest coöperation and critical study by each group that significant progress can be made. This can be accomplished (1) by showing the user the value of applying his knowledge of the properties and limitations of refractories in a critical study of specific conditions in service; (2) through the manufacturer obtaining the service data developing his material so as to furnish properties that will meet the service conditions to the greatest possible degree. Maximum life of the refractories under a given set of conditions in service will be obtained only by employing brick that have the specific properties essential for that service. Therefore, the properties of the brick that are to be purchased should be considered. This resolves itself into the use of specifications. Experiences with specifications to date, however, have not always been satisfactory and a little thought will reveal the cause of this condition. Specifications are an important factor and provide a common language concerning properties of refractories and service conditions, and the same operations and test methods will be used by all. They will set down a definite scientific outline of the refractories problem in each type of service and will supply a clearly defined objective for the manufacturer to follow. The development of the refractories field on such a scientific and organized basis should mark one of the greatest periods in its history of progress. Steady progress is being made in all branches of production in the selection of raw material, methods of forming and in firing.

Machine-made brick is more uniform than hand-made. Tunnel kilns and careful study of kiln firing are also aiding uniformity. The following comments regarding the various classes of refractory possibilities for advancement are given, some of which may not prove practical upon application. Clay refractories are usually made of a mixture of flint and plastic clays. A wide range of properties can usually be obtained by blending various percentages of these clays. In addition to such mixtures various methods of manufacturing are employed to produce desirable characteristics in the brick. The immediate outlook for greatly improved clays does not appear promising. Mention should be made, however, of the opportunity of purifying clay for use in manufacturing blast-furnace brick. The iron compounds present in nearly all refractory clays are causes of the disintegration occurring in these linings. Clays are treated for use in manufacturing glasshouse refractories and many of the other ceramic industries employ processes for purification, such as weathering, washing, elutriation, and magnetic separation. The chemical composition of the various clays used in the brick must be of importance to their behavior in service. For instance, if clays are employed in a brick mixture that vary widely in the silica-alumina ratio and total percentage of fluxes, there will be, in the heat treatment of service, various chemical reactions occurring in these dissimilar constituents. A refractory cannot be expected to maintain its original properties in service while such conditions exist within the brick. Obviously dissimilar physical properties of the ingredients will have like effects. Such reasoning applies to all types of refractories and is not limited to clay refractories. Another field of possible improvement is that of the control of the percentage of the various particle sizes of the materials used in compounding the batch. A study of this subject is now in progress and preliminary data appear to be of value. It is well known by practical brick men that the structure of the brick is often more important than the chemical composition of refractoriness. The structure of the finished refractory is not only dependent upon the process of manufacturing, but also upon the physical and chemical characteristics of the materials employed in compounding. Therefore, careful studies of the effect of calcined flint or plastic clay upon the brick should be conducted. The noteworthy innovation of recent years in the manufacture of silica brick is the adoption of the silica brick machine. Such mechanical molding of the brick should be an important factor in the production of more uniform brick. Evidently the properties of such brick are equal to the hand-made product and should be superior for obvious reasons. Another aid to the production of a highly uniform product would be the use of continuous kilns. This method of firing is now being seriously considered and will undoubtedly be employed in the near future. The high alumina content of the diaspore refractories make them resistant to unusually high temperatures. This fact, along with their chemical nature make them of particular value for a number of service conditions. Their utility can be extended, however, by minimizing their probable shrinkage in service and by increasing their density. A means of effecting these properties is now being studied and to date the results are promising. The possibilities resulting from the use of the sillimanite group of minerals (cyanite, andalusite, and sillimanite) for refractories has been a live subject in recent years. The physical and chemical properties of these materials are of a most promising nature. Their proper use in brickmaking has, however, required careful study and the full merit of the present products has not been established in many types of service. They appear to be of particular value in glassmaking furnaces. Their field will broaden in the future, filling the positions that cannot be satisfactorily met by other materials. The comparative cost of the raw materials will necessarily limit their use and place them in the class of specialties. A noteworthy refractory material of this class is the cast mullite. This product, which is simply a casting of an electric furnace melt, is of considerable interest. Raw materials of the composition

necessary to produce mullite are used for the melt and, after being cast, the shapes are annealed. The finished product has almost no pore spaces and is, therefore, of special interest in slag action. It has been found that the addition of low percentages of certain materials will substantially alter the properties of the finished casting, especially with regard to slag action. It is logical to expect that this principle will be applied to the manufacture of refractories of other compositions. Chrome, magnesite, and spinel compositions should prove to be of value to the steel industry. In recent years chrome refractories have found wider use by reason of their improved properties. In order to manufacture such superior chrome brick, it is essential that the highest grade of chromite be employed. By reason of the quality of ore needed and the large tonnage consumed annually, the question of supply is important. Means of purifying or utilizing lower grades of ore should be studied. Chemical treatment or electric furnace refining are possibilities. The resistance of chrome to high iron slags makes it of interest for boiler settings in which a coal giving a high iron ash is fired. Their comparative weakness at these furnace temperatures and sensitivity to thermal shock precludes their use in this service at the present time, but future developments should extend their use to this service. In recent years a highly calcined kaolin refractory has been marketed and like other special materials it is becoming established in certain limited uses. This product, by reason of the purity of the clay used in manufacturing and the exceedingly high temperature to which it is fired, possesses some unusual properties for clay refractories. Mention should be made of studies and the progress being made in the subject of testing refractories. Without adequate means of testing, progress in development and application of refractories is handicapped. Tests are the basis of specifications. The studies and experiences obtained in recent years have enabled technicians to develop noteworthy improvements in test methods and their use. Developments are leading to the simulation of actual service conditions and the lengthening of the time period of testing.

F.P.H.

Chemical constitution and refractoriness of molding sands. J. G. A. SKERL. Brit. Cast Iron Res. Assn., *Bull.*, No. 18 (1927); *Feuerfest*, **4** [1], 15 (1928). F.P.H.

Lining of the electric steel furnace. KOTHNY. *Feuerfest*, **4** [2], 17–20; [3], 34–42 (1928).—Subjects discussed are (1) factors influencing the durability or service of the electric steel furnace, (2) advantages and disadvantages of the acid and basic linings and the present day uses of these types of linings, (3) statistics on the types of electric steel furnaces in use throughout the world in 1921, (4) refractory coverings (roofs) for electric furnaces and the design of the brickwork for such coverings, (5) linings for high and low frequency induction furnaces, (6) advantages and disadvantages of various forms of hearths, (7) performance and service of electric furnace hearths, (8) design and construction of various forms of acid and basic hearths and coverings for the electric steel furnace. F.P.H.

Fireclay and silicate industry in the Ukraine. A. KRAMARENKO. *Feuerfest*, **4** [3], 42–45 (1928).—The following subjects are considered: (1) production of ceramic raw materials, (2) production of finished ceramic products, (3) condition and operation of ceramic plants, (4) properties of Ukraine quartzite, (5) description of ceramic processes used, (6) properties of the Tschassow-Jar Clay. The rational composition of this clay is as follows: clay substance 76.32%, feldspar 18.29%, free SiO_2 2.00%, and other constituents 4.07%; 85% of the particles of the clay are less than 7.5 microns in diameter and the clay is very plastic and refractory. The interval between the vitrification temperature and the fusion point is above 400°C. The clay is especially suited for the manufacture of heavy clay products. The chemical composition and other properties of this clay are given. A new plant has been finished and will make use of this valuable clay. The new plant is fully described. F.P.H.

Properties of silica and clay products in relation to industrial usage. ANON. *Gas World*, **88**, 14–17 (1928); *Feuerfest*, **4** [3], 47 (1928).—The following subjects are considered: (1) after-expansion and after-contraction, (2) spalling, (3) thermal properties, especially heat conductivity, (4) insulating value, (5) behavior toward corroding and eroding influences. F.P.H.

Refractory material for vertical retorts. E. STEINHOFF. *Gas World*, **88**, 72–73 (1928); *Feuerfest*, **4** [3], 47 (1928). F.P.H.

Spalling of refractory brick. W. MIEHR, J. KRATZERT, AND H. IMMKE. German Assn. Mfgrs. of Refrac. Prod., *Tech. Pub.*, No. 9; *Tonind. Ztg.*, **52** [4], 56–60; [5], 77–78 (1928).—A discussion is given of 7 methods (5 of which have been used in America) of determining the resistance of refractory products to sudden changes in temperature. The American methods do not simulate plant practice and are criticized on this basis. The method used by the writers consists in building into the test furnace the brick that are to be tested, heating them to 1350°C, and spraying them with a definite amount of water under a known pressure. When the brick have reached room temperature this process is repeated. The method and apparatus used is described in detail. Results are presented on 9 different refractories of varying Al_2O_3 content. A bibliography of spalling tests on refractories is given. F.P.H.

Refractories and highly-refractory materials. F. PLATE. *L'Industria*, **42** [31], 33–35 (1928); *Feuerfest*, **4** [3], 47 (1928).—A discussion is given of (1) properties of refractory materials, (2) porosity, (3) spalling, (4) resistance to chemical attack, (5) heat conductivity, (6) requirements for highly-refractory materials. F.P.H.

Sand setting and devices for setting and classifying sand. III. EDMUND SHAW. *Rock Prod.*, **31** [7], 38–40 (1928).—The designing of a surface setting box is described. F.P.H.

Production and use of graphite. BENNO SCHMIDT. *Tonind. Ztg.*, **52** [10], 173–75 (1928).—The composition, sources, and production statistics of graphite are given. F.P.H.

The melting point of coal ash. KARL D'HUART. *Centralblatt der Hütten und Walzwerke*, **30** [38], 401–405 (1926).—The 4 stages in heating an ash to complete fluidity are (1) the point of incipient fusion or temperature at which the ash begins to stick together; (2) the softening point at which the ash cone, made according to the method for the usual melting of Seger cones, changes so far that the cone tip touches one of the cone sides or the plane; (3) the point of beginning melting or temperature at which the first traces of melting show; and (4) the real melting point or temperature at which the ash is completely molten. Tests were run on melting points of ashes and the effects of atmosphere thereon, showing that the melting points of ashes were highest in either strongly reducing or strongly oxidizing atmospheres. In 1895 Bischof worked out a formula for a refractory coefficient, Q, based on the chemical composition of the material, as follows:

$$Q = \frac{a}{c} \times \frac{a}{b} = \frac{a^2}{bc}$$

where a = the amount of oxygen in the alumina, b = the amount of oxygen in the silica, and c = three times that in the fluxes. Prost in 1897 changed this to Q = (oxygen in alumina)^2/(oxygen in silica)(oxygen in the oxides of iron, calcium and magnesium), and stated that when Q is greater than 3, the ash is infusible at 1500°C; when Q lies between 1.5 and 2–3, it melts at about 1450°C; when Q lies between 1 and 1.5–2, the ash melts at about 1350°C; and if Q is less than 1, the ash melts below 1200°C. Data collected by Roszak on 30 ashes, including chemical analyses, oxygen content of the oxides, the values for the coefficients a, b, and Q, calculated and actual melting points are given.

His method of testing is described. The study of ash fusion points can be traced back to a study of the system silica-alumina-lime-iron oxide, if the remaining ash constituents are regarded as impurities and are considered according to Raoult's law. E.J.V.

Air-cooled walls prevent baking on of slag. E. BURMESTER. *Centralblatt der Hütten und Walzwerke*, **31** [8], 97 (1927).—A discussion of the use of air-cooled furnace walls where hard coal is used for fuel, to avoid heavy slag coating of the walls and thus prolong their active life. E.J.V.

Production of slag brick. GEORG WEGNER. *Centralblatt der Hütten und Walzwerke*, **31** [12], 143–44 (1927).—A discussion of the methods used in manufacturing brick of crushed blast-furnace slag. E.J.V.

Protection of fireclay linings and flues of industrial furnaces. H. HAWIRA. *Centralblatt der Hütten und Walzwerke*, **31** [16], 203–204 (1927).—A discussion of the use of a silicon-carbide waterglass coating to protect fireclay linings and flues of industrial furnaces against both abrasive action of dust and chemical attack by the acids in flue gases or the alkalis in the slags. Silicon carbide being harder than fire clay can withstand abrasive action much better, and being a neutral material is less liable to chemical attack. E.J.V.

Firing refractories with stokers. E. B. PRENTICE. *Clay-Worker*, **89** [5], 378–79 (1928).—For abstract see *Ceram. Abs.*, **7** [6], 395 (1928). E.J.V.

Temperature measurements by softening under load test on refractory materials. W. MIEHR. *Die Messtechnik*, **2** [7], 94–95; [10], 190–93 (1926).—Means of measuring temperatures by the softening of refractory materials under pressure are discussed. The advantages of horizontal temperature measurements are listed. Comparisons are made of temperature measurements according to Endell-Steger, M., and by means of thermo-elements. E.J.V.

Heat-transfer through ceramic materials. MAX JACOB. From Part III, "Die Keramik im Dienste von Industrie und Volkswirtschaft" by Felix Singer and Assoc. Trans. by W. L. Shearer and A. W. Holtzmann. *Ceram. Age*, **11** [4], 121–30 (1928).—Products of low conductivity save heat when used as insulation, those of high conductivity are desirable in many cases when heat must be transmitted. From this standpoint, the proper application of ceramic materials is made difficult by the confusion which exists regarding the conceptions of heat conductivity and lack of adequate experimental data. Heat may flow from one body to another or inside of one body. The first case is called heat-transfer. Inside a body we may have a steady state or a variable heat flow. The former is governed by the property known as thermal conductivity, the latter by a value combining the density, specific heat, and thermal conductivity which is usually called temperature conductivity. (Abstractor's note: diffusivity.) J. defines the following quantities by means of equations and discusses their significance and the factors upon which they depend: heat-transfer constant, radiation constant (emissivity), thermal and temperature conductivity (diffusivity). The connection between diffusivity and the storage of heat in conductors is brought out. J. explains why well-known methods lead to contradictory results and need careful criticism. In general steady-flow methods are best. In most modern methods, electricity is used as a source of heat, the electric power input is used in calculating the quantity of heat, and thermocouples are used for measuring temperatures. J. describes the following methods of measuring steady heat flow: electrical internal heating of a hollow sphere, due to Nusselt; internal heating of hollow cylindrical shapes, by Clement and Egy, van Rinsum, etc.; tests of plates by Gröber and Poensgen, van Dusen, Jacob, etc.; and the calorimetric method of Pectlet, Wologdine, Goerens, Dougall, Hodsman and Cobb. Methods of measuring variable heat flow are (1) heating one surface of the test piece or wall rapidly, due to Heyn, Bauer, and Wetzel; and (2) sine-wave heating by Honda

and Sato, and Tadokoro. J. gives a very comprehensive table of the thermal conductivities, diffusivities, and other related properties of ceramic materials and others of importance in the ceramic industries. By an analysis of the data given in the table, J. draws the following conclusions regarding the factors affecting thermal conductivity: (*a*) the influence of chemical composition cannot be determined accurately from the data, although silica brick have 50% greater conductivity than fireclay brick; (*b*) thermal conductivity increases with apparent density; (*c*) moisture increases conductivity; (*d*) conductivity increases with temperature for amorphous materials but decreases for crystalline materials; and (*e*) the lack of agreement found in the case of magnesite brick can be explained on the basis of conclusion (*d* above) and is due to variation in crystallinity. A.E.R.W.

Electric steel manufacture. F. T. Sisco. *Fuels and Fur.*, **6** [5], 589–600 (1928).—S. describes in detail the manufacture of electric steel by both the basic and acid processes. In the acid process the furnace is lined with acid (silica) refractories and the slag is acid in character; in the basic process, a basic lining is used and the slag is basic in character. For a basic bottom, dead-burned magnesite mixed with a little basic slag, tar, or molasses is rammed and sintered into place. Bottom repairs are usually made with dolomite or, in some cases, magnesite. Analyses are given of both basic and acid slags from furnaces having different atmospheres. A.E.R.W.

Graphites. Anon. *Brit. Clayworker*, **37** [432], 34 (1928).—In the manufacture of crucibles the structure of the grade of graphite employed has a far-reaching effect on the strength of the former. Microscopical examinations have demonstrated that consistently large particles of graphite prove less efficacious than those consistently small. In a mixture of clay and small grains of graphite, plasticity of the clay is reduced to the minimum. When the flaky variety is employed, not only is plasticity reduced to the minimum, but the flow of the mass under pressure is disturbed. This disturbance occurs to a greater extent in the direction perpendicular to the plane of the flakes than in other directions. A tendency to break the bond is exhibited by any movement in a similar plane. The natural direction of the flow is parallel to the flakes, and if the flow is too great, this occurrence may result in excessive slipping during molding of the pot. Consequently with the admixture of granular ceylon graphite to the clay, the mass becomes more consistently plastic and may be more readily worked, exhibiting less tendency to rupture than a body containing flake graphite. Ceylon graphite seldom flakes and is composed of very thin laminae not running continuously. American graphite breaks occur at right angles to the outer face. Alabama flakes are as a rule the thinnest of American graphites. Pennsylvania flakes are larger and thicker while Canadian flakes are more regular and larger. Madagascar graphite is almost twice as thick as American graphite. The bond clay for crucible for melting brass should fire moderately dense and strong at about 1100°C with no alteration in structure up to 1250°C. For use in steel melting a bond clay which is more refractory, dense, and strong from 1400 to 1600°C is desirable. R.A.H.

Thermal expansion of fire clays. Anon. Bur. Stand., *Tech. News Bull.*, No. 132, p. 53 (1928).—The linear thermal expansion has been observed from room temperature to 900°C by means of the interferometer on a total of 25 clays fired at 1400°C for 5 hours. These clays are used in the manufacture of 17 brands of fire brick. The clays may be grouped into 4 groups according to the type of expansion, *i.e.*, whether regular or irregular. Pronounced differences were noted between the observed expansion of some of the clays and the bricks made of these clays due to either manufacturing process or addition of grog. R.A.H.

Industrial graphite. H. N. Kay. *Chem. Trade Jour. and Chem. Engr.*, **82** [2128], 217–19 (1928).—Graphites from Madagascar, Ceylon, and Bavaria are in flakes that

have a metallic luster. Other varieties such as Korean, Australian, Czechoslovakian, and Italian are dull and have no recognizable crystalline structure. The physical properties of graphite are so variable that there is no criterion by which to judge a sample of carbon. The physical properties are described in some detail. Much graphite is used in making crucibles which have the following advantages over clay crucibles: higher refractory value, higher heat conductivity, better resistance to temperature change. The most important property of graphite is that it reduces metallic oxides and so prevents the formation of dross. The graphite for crucibles must not burn readily, and usually a coarse flake is chosen. Impurities have important effects on graphite. Pyrites and calcium carbonate are most objectionable. Graphite is used to a considerable extent in foundry sand, while its principal use is in the making of pencils. It is also an excellent lubricant and is used for this purpose largely where oils are unsuitable, such as at very high or very low temperatures, and for slow moving parts under very heavy pressures, as well as in the manufacture of foodstuffs such as chocolate because of its absence of odor. L.P.C.

Refractories for the glass industry. I. W. J. REES. *Glass*, **4** [3], 96–97 (1927).—The measurement of the drying shrinkage of clays gives information of considerable utility to the clay worker. A clay with large drying shrinkage should be mixed with a leaner clay or with nonplastic such as grog to reduce the shrinkage. The shrinkage of a pot-clay or tank-block mixture after thorough air drying should not be more than 6%. The method of the AMERICAN CERAMIC SOCIETY is recommended for the determination of drying shrinkage.[1] The tensile strength of clays is important especially if they are to be used for making pots and other hollow ware. The method for testing cement as used by the A.S.T.M. is recommended for determining the tensile strength of clay or clay bodies. The firing shrinkage is determined in a manner analogous to that used for the drying shrinkage. Clays which show small alternating volume changes in the temperature range 750–800°C are not desirable constituents of a pot-clay mixture. When the main firing shrinkage commences it should continue regularly up to a temperature not lower than 1400°C. In siliceous clays the contraction is modified by expansions due to changes occurring in the free silica. Clays which show a large firing shrinkage need admixing with grog in order to reduce this shrinkage. As Mellor has pointed out, the main contraction of a fire brick is due to a change which is analogous to the tendency of liquids to assume a shape which presents the smallest possible surface area. When the fluxes in the clay soften they draw the more refractory grains into closer contact. If the clay is low in fluxes the latter become saturated with clay and silica and form a practically infusible solution at the particular temperature. Heating to a higher temperature is necessary before this solution can melt. The processes of solution and contraction then continue. **II.** *Ibid.*, [5], 184–85 (1927).—In fired bodies it is necessary to distinguish between true and apparent porosity. Because of the presence of closed pores the true porosity is higher than the apparent porosity which takes into account only the open pores. Clays for use in pot- and tank-block manufacture should show a steady reduction in porosity and volume, especially over the temperature range 1150–1450°C, and should be fairly dense at 1400°. The shrinkage over the temperature range 1000–1450° should not exceed 5% and there should be no indications of overfiring on continued maintenance in the temperature range 1400–1500°C. Clays with a long range of vitrification and slow decrease in porosity are not suitable for use in the production of glass refractories because they do not satisfy the density requirements of such refractories unless a very high firing temperature is employed. The porosity of a clay body in contact with melting batch and molten glass may be a determining factor in its durability, in regard to its resistance to both corrosion

[1] See *Standards Report, Jour. Amer. Ceram. Soc.*, **11** [6], 450 (1928).

and erosion. A distinction between fine and coarse porosity must be made. A clay body with large pores is more easily penetrated than one with small pores. The grog admixture, tempering, treading or pugging, and maturing should be so controlled as to produce with normal manufacturing procedure a body of uniform and fine porosity. As the use of grog tends to increase the porosity of the body it is desirable that it be angular and well graded so that it packs well and gives a minimum of voids. High porosity is necessary for special purposes such as thermal insulation. This high porosity is obtained by adding wood or cork dust with the clay. These combustibles are burned out when the clay is fired. With a clay of good bonding power and tensile strength as much as two volumes of sawdust to one volume of clay may be used. Houldsworth and Cobb have shown that up to a porosity of 50% an increase of porosity is accompanied by a decrease in the coefficient of expansion. With porosities over 50% the change in thermal expansion with change of porosity is small. **III.** *Ibid.*, [6], 232–33 (1927).—The strength of the air-dried clay used in pot and clay mixtures for feeding devices is of great importance because of the stresses set up in handling. This also holds true for tank blocks but to a lesser degree because of the greater thickness and more regular shape of the pieces. Modern practice requires the use of more complex mixtures for fireclay goods which are subjected to the action of molten glass. These mixtures contain three or more constituents, usually a plastic or bond clay, a refractory base clay, and grog. The relative proportions of the latter two depend upon the strength or bonding power of the plastic clay; the higher the bonding power the greater is the permissible proportion of the other two. The grog particles should be angular and graded in size so that they present the maximum surface area to the bond clay and interlock freely. The use of rounded grog particles gives a body of low mechanical strength. The compressive strength of air-dried pot clay of good texture should be 80–150 lbs. per sq. in. The mechanical strength at high temperatures or refractoriness-under-load is a most important property of pot mixtures. This is very important with large pots or pots which are handled at high temperatures. At high temperatures a viscous condition is gradually developed and the body is weakened. Mellor and Moore have given the formula $T=ce^{-kw}$ to show the temperature of deformation under load. T is the load at which rapid collapse takes place under a load of w lbs. per sq. in.; c is the cone result of the normal refractoriness test; k is a constant characteristic of the particular clay; and e the exponential function. From this is derived the generalization that the more siliceous a clay the less the effect of load on the squatting temperature. The effect of fluxing impurities, however, may reduce the refractoriness of the matrix and cause a reduction in viscosity with the result that the generalization will not hold. It is important that well-graded angular grog be used in the pot mixtures because the resistance to deformation under load is increased thereby. Furthermore, the use of grog controls the shrinkage and drying of the pot or block. A.J.M.

Dilatometric measurements on tridymite and cristobalite. C. J. Van Nieuwenburg and H. J. Zijlstra. *Recueil des travaux des Pays-Bas.*, **47** [1], 1–12 (1928).—The authors call the β modification that one which is stable at a higher temperature than the α modification. The regions of stability of the various forms of silica are reviewed. Objections have been raised to the accepted temperatures and all methods of testing the correctness of Fenner's results involve the differentiation of quartz, tridymite, and cristobalite. Quartz is easily distinguished from the other two by its higher specific gravity, the much higher refractive index, and the greater degree of double refraction. The sharp distinction of tridymite and cristobalite remains an uncertain matter. A point of technical importance is attached to this distinction because it is believed that the volume change accompanying the inversion of α to β cristobalite is one of the causes of spalling of silica brick. The following methods have been used for distinguishing between tridymite and cristobalite: (1) *Specific gravity.* The specific gravities of cristo-

balite and tridymite lie very close together and are known with too small an accuracy to be used for distinguishing between the two modifications. Furthermore, the determination of the true specific gravity of a finely powdered substance which is full of little cracks presents insurmountable difficulties because of the air which is held so tenaciously. Frequently the preparations are rendered impure by the presence of amorphous silica of low specific gravity and the results are in error. (2) *Differences in crystalline form.* These offer little certainty because they deal with much splintered crystalline dust which even under the microscope shows little or no sharp boundary surfaces. (3) *Difference in double refraction.* Quartz is strongly double refracting while the others are practically not so. The fact that tridymite is positively doubly refracting and cristobalite negatively does not help much because in artificial preparations no orientation of the crystallographic axes can in general be found. (4) *Difference in refractive index.* Experience has shown that the difference is too small to permit of a definite distinction in the case of unsuitably shaped splinters or of very fine dust. (5) *Transition points.* This method is not only precarious but is applicable only to reasonably well-shaped and fairly large crystals which are rarely met with in practice. (6) *Thermal analysis.* No usable, reproducible results are obtained by this method. (7) *Thermal expansion.* This method is more satisfactory than the others but does not allow semiquantitative determinations which are very desirable and important. A cementing material must be used and this may cause discontinuities. V. N. and Z. investigated their materials by means of ordinary liquid or gas dilatometers and easily found the inversion point of cristobalite at about 225°C. But they did not succeed in showing the least irregularity with tridymite. They draw the following conclusion. Neither of the two transition points of tridymite is connected with alterations in the true specific gravity which make a difference in the second decimal or in other words, any changes of volume which do occur amount to less than 0.2%. Measurements on rods made by other experimenters have shown volume changes of about 0.8%. The authors conclude that an error of principle has been made. They believe that it is incorrectly assumed that the alteration in length of a rod is a measure of the alterations in density of its structural constituents. It is possible for an inversion to take place without any change in the density of the substance. There is, of course, a recrystallization. Thus, a large splinter may change into a conglomerate of new crystals but with interstices between them. This effect would give a change in the length of the specimen but there would be no increase in density. The method is useful for confirming a transition point but cannot be used for quantitative determinations. The authors decided to conduct measurements of expansion direct on the powdered preparations. The powder to be investigated ($^1/_2$ to 1 gram) is contained in a small cylindrical cuvette. On the powder rests a short cylinder and on this a longer rod. The cuvette rests on a support which is made of quartz glass. The cuvette has a deep projection in the bottom for the introduction of a thermocouple and is situated in the center of a block of brass which is electrically heated. The whole is well insulated and is enclosed in an aluminum cover which is movable along two guides. The long quartz rod works with a very sharp edge on a simple freely moving pointer which carries an ocular micrometer scale. This is read with a simple reading microscope with a cross-wire in the eye-piece. The leverage of the pointer is about 1 to 48. The tridymite used was prepared from finely ground pure quartz by heating this with sodium tungstate as a flux. The tridymite and cristobalite were practically pure. Five determinations on the cristobalite showed that the inversion intervals were not so long that they could not be considered as a transition point which was extended somewhat by inequalities in the temperature distribution. The transition point of α to β cristobalite may be fixed at $220° \pm 5°$. The previous heat treatment and method of preparation do not appear to have the significance given them by Fenner and by

Endell and Rieke. The deviations were never greater than 15°. The transition β to α cristobalite, with falling temperature, is found to be 20–30° lower than the same inversion with rising temperature. With tridymite two transition points are clearly shown at about 100 and 140°. The transition of α to β tridymite is found to be $100° \pm 7°$ while the β to γ tridymite inversion is found to occur at $141° \pm 7°$. These values are considerably lower than those given by Fenner. Tridymite undergoes some further transformation at 440° where a sudden diminution of coefficient of expansion occurs without a corresponding alteration in length. With a constant method of procedure it is possible to obtain from the observed expansions with mixtures of tridymite and cristobalite an idea of the amount of each component which is present. The expansions occurring are proportional parts of those which are observed with the pure products. Since the alterations in length are so much greater with cristobalite than with tridymite it is possible to detect more easily small quantities of cristobalite rather than of tridymite. Experience has shown that the presence of 5% of cristobalite and 10% of tridymite appear with complete certainty in the expansion diagrams. When larger quantities are present the content can be estimated with a relative accuracy of 20–25%.

A.J.M.

A consideration of the properties of silica and fireclay products in relation to the carbonizing industries. A. T. GREEN. *Gas Jour.*, Special No., 65–77 (Feb. 14, 1928).—A discussion with an extensive list of references appended. (*C. A.*)

Fusion of coal ash. K. BUNTE AND K. BAUM. *Gas u. Wasserfach*, **71**, 97–101, 125–30 (1928).—The fusion point of coal ash from a series of American coals previously tested by the U. S. Bureau of Mines was redetermined in a C resistance furnace using cones slightly larger than are used in the American gas-furnace method. The results agreed well with the results previously reported. A new method was developed for following the plasticity and deformation of the ash during the fusion process. Cylinders of the ash 3 cm. in diameter and 3 cm. high were fused in the C resistance furnace. Graphite rods above and below the ash cylinder transmitted changes in length to a recording device. Graphs for changes in length *vs.* temperature are shown for the 7 coals, and the results interpreted. The influence of various ash constituents and their mixtures on the fusion point of coal ash is discussed. The variety of the possible compounds that may be formed during fusion or may be present before fusion precludes the possibility of accurately estimating the fusion temperature from analyses. The necessity of much more work on the fusion process is indicated. (*C. A.*)

BOOK

Refractory material for iron and steel works. L. LITINSKY. *Feuerfest*, **4** [2], 30–32 (1928).—A bibliography on refractory material for iron and steel works. Most of the references are to the literature of the last 15 years. F.P.H.

PATENTS

Heat-insulating material and the process of its manufacture. WILLIAM W. ODELL. U. S. 1,657,582, Jan. 31, 1928. A solid, cellular, noncombustible, heat-insulating material comprising the molded and subsequently dried and fired product resulting from the intimate mixture and maceration of plastic clay and prepared alkaline peat containing a certain maximum percentage of water which is only the amount required to give the mixture sufficient plasticity to be worked, macerated, and molded.

Producing refractory material. JOSEPH G. DONALDSON AND HENRY L. COLES. U. S. 1,668,306, May 1, 1928. As a new material, an alloy consisting of copper, approximately .60 to .75% silicon, and less than 1% carbon.

Purification of alumina. ALUMINUM CO. OF AMERICA. Brit. 262,405, Nov. 3, 1926. In the electrothermic treatment of clays and bauxites to obtain a ferrosilicon-titanium

alloy and a fluid alumina slag, the charge is so adjusted that the latter contains at least 95% Al_2O_3. During pouring it is blown with an oxidizing blast of air or steam (or both) and the hollow globules so obtained are treated with an acid solution which will remove all the lime and most of the ferric oxide, titania, and silica. As leach liquor, sulphuric, hydrochloric, or hydrofluoric acid may be used, or mixtures which generate these acids, *e.g.*, sodium chloride and sulphur dioxide in the presence of air. The purified alumina so obtained contains 99.5–99.8% Al_2O_3. (*B. C. A.*)

Saggers for chinaware, etc., formed of nickel-chromium or other nickel alloy or similar refractory wire or tape. B. J. MOORE AND A. J. CAMPBELL. Brit. 269,741, May 17, 1926. (*C. A.*)

Manufacture of alumina from bauxite, clays, etc. J. C. SEAILLES. Brit. 277,697, Sept. 19, 1927. To render the alumina content more readily soluble, clays are calcined at 650–750° and bauxite at 500–600°. In either case the calcined product is heated with a solution or suspension in water of an alkaline-earth hydroxide either with or without pressure. With barium hydroxide a solution of barium aluminate is obtained which is separated from the insoluble portion and treated with sodium carbonate or sulphate to obtain a solution of sodium aluminate, from which alumina may be precipitated and sodium carbonate regenerated by known methods; the barium sulphate or carbonate precipitate is converted into hydroxide for further use in the process. An alternative procedure consists in treating the barium aluminate solution with lime to precipitate calcium aluminate (which is converted into the sodium salt as described above), and to regenerate directly barium hydroxide. In case calcium hydroxide is used to decompose the ore the whole of the alumina remains insoluble as calcium aluminate, which is converted into the sodium salt by digestion with sodium carbonate under pressure. The aluminium hydroxide obtained by the above processes is claimed to be practically free from silica and a high recovery is effected. (*B. C. A.*)

Production of cellular heat-insulating material. A. U. WESTFELT. Brit. 283,055, May 28, 1927. In the production of fire brick, water-glass is mixed with potassium chlorate and, if desired, a powdered silicate, and heated. (*B. C. A.*)

Disintegration of liquid alumina. A. L. MOND. Brit. 284,131, June 7, 1927. Fused alumina is transformed into small, easily separable crystals suitable for fusion electrolysis by disintegration of the molten mass with rapidly rotating disks or paddles, or by blowing with air or other gases, followed by rapid cooling by water as rain or spray, or by projecting the disintegrated material into a chamber irrigated with water, the particles being collected in a container through which water flows. Means are provided for preventing both premature solidification of the molten alumina and the steam evolved from coming into contact with the hot or non-disintegrated material. (*B. C. A.*)

Terra Cotta

Ultra-sonics and architectural sound insulation. R. W. BOYLE. Nat. Res. Council Canada, *Ann. Report*, **10**, 85–86 (1928).—Ultra-sonics are sound waves with frequencies more rapid than those perceptible by the human ear. Like any other waves, they can be made to show modes and loops, and when passed through partitions placed in their path, reflection will be at a maximum or minimum, and transmission at a minimum or maximum, according as the thickness of partition is equal to an odd or an even number of quarter wave-lengths. These results have a practical bearing on the problems of sound insulation in buildings. H.H.S.

White Wares

"True" specific gravity of feldspars. ANON. Bur. Stand., *Tech. News Bull.*, No. 132, pp. 54–55 (1928).—A Hubbard type pycnometer was used for determining the

specific gravity of 19 feldspars. The method of procedure is described and the conclusion arrived at that since there is a difference of only 2% between the greatest and least specific gravities of the 19 feldspars covering the field from albite to microcline it is doubtful whether the determination of specific gravity will have any value as a practical test to determine the type of feldspar purchased. A table is given showing the effect of fusing and partially fusing feldspars when heated to cones 4, 8, 10, 12, 13, and 14. R.A.H.

Causes of yellow discoloration obtained in firing porcelain. M. MIELDS. *Sprechsaal*, **61** [2], 22–23 (1928).—A short review and discussion of the principle reasons for and against the two present theories that the yellow color obtained in firing porcelains is due to (*a*) atmosphere and (*b*) smoke. R.A.H.

Decorating of porcelain. MAX SCHNEIDER. *Sprechsaal*, **61** [3], 40–42 (1928).—A discussion of procedures involved in printing of designs on porcelains by decalcomania and metal plates. R.A.H.

Lead-containing and lead-free glazes. JACOB KLUG. *Sprechsaal*, **61** [5], 79–82 (1928).—Consideration of the possibility and suitability for the substitution of lead-free glazes for those containing lead with particular consideration to the manufacture of stoneware utensils. R.A.H.

Ceramic insulators and their testing. FRIEDRICH RIEDIG. *Keramos*, **7** [2], T3 (1928).—A description is given of the various forms of insulators and the latest testing equipment exhibited at the equipment show in Berlin, November, 1927. Some data on the latest electrical porcelain are as follows:

	Porcelain kg./mm²	Stoneware Kg./mm²	Steatite Kg./mm²
Compressive strength	4500–5500	5800–7900	8000–9200
Tensile strength	240–520	160–520	550–720
Bending strength	400–900	600–950	950–1200
Torsional strength	250–500	210–230	500
Modulus of elasticity	8000	4200–5600	10,000

F.P.H.

The fired color of porcelain. H. PAETSCH. *Keramos*, **7** [3], T2 (1928).—A discussion is given of the effect of the composition of the fuel and the kiln gases on the porcelain. The ultimate composition of a number of European fuels is given. F.P.H.

Underglaze colors for porcelain. ANON. *Keramos*, **7** [3], T4 (1928).—The composition of a great number of underglaze colors that have been successfully applied and the glaze formulas used with the various colors are given. F.P.H.

Muffle colors for porcelain and their application. ANON. *Keramos*, **7** [4], T4 (1928).—The batch formulas for so-called "muffle colors" for porcelain are given. Most of the glazes mature between cones 022 and 012a. F.P.H.

Electromagnetic separators. ANON. *Pottery Gaz.*, **53** [611], 781–85 (1928).—At the April meeting of the Ceramic Society of England, W. E. Box read a paper on "Electromagnetic Separators for the Pottery Trade." The deleterious effects created by iron particles which may be left in pottery clays are discussed. The source of the black speck in pottery is generally from some iron material which finds its way into the raw material during handling and the preparation processes. At first these objectionable specks were gotten rid of by passing the material over permanent magnets in troughs, but now the electromagnet has been brought into use. The principles of magnetic separation are discussed. Two types of magnetic separators for the treatment of wet materials are described. Of the new kinds of separators now coming more and more into use for the electromagnetic treatment of dry materials, the rotary and chute separators are most prominent and are described. E.J.V.

Influence of titanium on the coloring of clayware. E. KLEVER. *Keram. Rund.*, **36**, 101–102 (1928).—The presence of Ti may cause a bluish to purplish color in fired clayware. The color is most frequently produced when (1) the ware is fired to the sintering point and (2) a reducing fire is used. Fe_2O_3 may mask the coloring effect of Ti. H.I.

King-tê tschen, the porcelain city of China. ERNST ZIMMERMANN. *Keram. Rund.*, **36**, 106–10 (1928). H.I.

Laboratory porcelain. N. SHELDON. 4 pp. Brit. Assoc. of Chemists, London, 1928.—British laboratory porcelain dates from 1915, during the war period. The Royal Worcester Co. now makes two brands: (1) Royal Worcester and (2) Sillax. The former is vitrified to an extent that makes it impermeable to gases up to 1350°C. The glaze on it does not soften until heated to 1100°C for 4 hours; it is thus harder than the Royal Berlin glaze. The new variety, "Sillax," is a mass-production ware, cheaper, and made only in certain popular sizes. It is reported by laboratories to be superior to the cheap continental makes. H.H.S.

PATENTS

Spark plug. ISAAC HARRIS. U. S. 1,666,853, April 17, 1928. A spark plug comprising a shell, an insulating core within the shell, the core being provided at one end with an enlarged head having a chamber therein, a sectional power electrode having one member thereof extending longitudinally through the insulating core and having a spiral formed at one end thereof, and located within the chamber, the other member being supported in alignment therewith and having a portion thereof extending concentrically with the spiral portion, a ground electrode secured to the shell and having a loop portion surrounding the power electrode.

Spark plug. GEORGE EDWARD THEIS. U. S. 1,667,960, May 1, 1928. In a spark plug, a shell having an inner beveled shoulder, an insulator within the shell having an annular enlargement beveled upon its lower face to match the beveled shoulder of the shell, a temperature compensating ring mounted upon the insulator between the enlargement thereof and the shoulder of the shell, and having the outer portion of its lower face and the inner portion of its upper face similarly beveled to match the beveled faces of the shoulder and enlargement, and having the inner portion of its lower face and the outer portion of its upper face flat and parallel, and compressible gaskets at opposite sides of the ring and confined between it and the shoulder and enlargement.

Insulator. FREDERICK H. MILLER. U. S. 1,669,529, May 15, 1928. (1) A high-potential suspension insulator of the cap-and-pin type comprising a refractory dielectric portion of substantially cup-shape, a tension pin including a fibrous insulating portion and one end secured in position in the cup portion, and means for totally enclosing the pin including a metal terminal member at each end of the pin and a tubular refractory portion surrounding the sides of the pin. (2) A high-potential suspension insulator of the cap-and-pin type comprising a refractory dielectric body member having a head portion of substantially cup-shape, a pin including a fibrous insulating portion and one end bonded in position in the head portion, and means on the pin including a covering on the end having better coöperation with the bonding material and with the fibrous material than exists between the fibrous material of the pin and the bonding material.

Spark plug. ARTHUR R. MOSLER. U. S. 1,669,992, May 15, 1928. In a spark plug, a center spindle having a hole in its inner end, an electrode fitting the hole and itself having a hole in its outer end, and a hard metal ball located in the holes, arranged to crowd the walls of the electrode hole laterally into locking engagement with the walls of the spindle hole.

Electric socket with shade holder. DON N. THOMPSON. U. S. 1,668,703, May 8, 1928. An insulating shade ring for electric sockets having an annular surface and an

inner cylindrical surface, a screw passing freely through the ring and cylindrical surface, a recess in the cylindrical surface, a nut in the recess engaging the screw and means in the annular surface to prevent inward movement of the nut.

Process of uniting vitreous pieces. BERNARD LONG. U. S. 1,668,853, May 8, 1928. A process of uniting vitreous surfaces which consists in accurately fitting the surfaces to be joined, and producing thereon a smoothness such as produced by grinding with fine emery, applying to the surfaces while hot a thin film of heated synthetic resin such as a phenol and formaldehyde condensation product and uniting the surfaces under pressure and heat.

Tile simulation. JONATHAN GRAHAM WALDRON. U. S. 1,669,639, May 15, 1928. A tile simulation comprising a sheet metal body provided at its edges with projecting nailing flanges to interfit with similar flanges of another simulation, a number of strips being spaced apart at corners of the simulation while another strip extends across the contiguous ends of adjacent strips for the purpose specified.

Electric insulators. STEATIT-MAGNESIA AKT.-GES. Brit. 285,453, April 12, 1928. The pin of an insulator is fixed in the cavity in the insulator body by pressure rings comprising members strung on springy steel wire and fitting in semicircular grooves in the body. The members may consist of thick-walled rings of iron, copper, or brass having oblique end faces and may be coated with lead, or the members may be thick disks of cylindrical form or curved to the shape of the grooves. A further modification contains thin annular metal disks strung on wire. Eyes on the wire facilitate introduction of the members into the grooves, a dummy filling being inserted in the outer groove while the inner groove is being filled. Pressure transmission rings are fitted between the rings and are made in two or more parts laid over the pin which has a head. The space between the pin, the rings, and the insulator body may be filled with lead.

Pottery shaping. W. J. MILLER. Brit. 285,871, April 18, 1928. In connection with jigger mechanism for shaping pottery ware, means are provided for retaining the mold in temporary positive association with the chuck during the shaping operation. The chuck is surrounded by a metallic ring which is provided with a wire coil and commutator rings adapted to contact with brushes adjustably mounted in a support. The brushes are connected with a supply of current and when the chuck is in raised position the base of the mold is caused to adhere to and rotate with the chuck. A stud is mounted on a spring in a central recess in the chuck and is retained in position by a collar which allows sliding but not rotary movement of the stud. Transversely disposed spring-pressed pins are mounted in the stud from which they are adapted to project into grooves of spiral form arranged in the inner side of the projecting wall of the metal mold. When the chuck is raised and rotated the pins will automatically engage the grooves and cause the mold to rotate with the chuck. The chuck is also provided with an annular boss for engagement by the inclined projecting walls of the metal mold. A band brake may be fitted at the lower part of the chuck, the contact of a projecting bolt of the brake and a stop on the fixed frame being arranged to stop gradually the rotation of the chuck. A vertical passage is provided in the spindle, chuck, stud, and base of the mold and is adapted to communicate with the recess and also the recess of the chuck. A sealing ring is attached around the upper periphery of the chuck so as to engage the metal part of the mold when the chuck is raised. The lower part of the passage communicates alternately with ports formed in a plunger valve which works against the pressure of a spring interposed between the plunger and a pipe. The pipe opens to atmosphere or to any pressure-supplying agency, and the port is provided with a pipe connected to suction-applying means. A cam adjustably mounted on a shaft is adapted to operate the plunger in timed relation to the jigging operation. The mechanism for reciprocating and rotating the mold is of known type and comprises a fork, rod, pivoted lever, and

cam for reciprocating the mold and friction disks for intermittently rotating the mold. The metal base of the mold is provided with an annular ridge for receiving the plaster body. Holes are provided in the plaster body and holes in the metal base, and these communicate with the passage. The port of the plunger is caused to register with the passage after the top edge of the sealing ring reaches the level of the mold base and suction is then set up between the chuck and mold base and body portion and mold base. This suction may be communicated through the charge by means of small holes in the mold body. At the same time as suction is being applied, the electromagnet operates to hold together the chuck and metal base. Pressure may be applied through the passage to assist in ejecting the article from the mold. A switch is used with the plunger valve for reversing the polarity of the ring after each shaping operation. If the chuck in such a case is of reciprocating type, the brushes are adjusted to remain in contact with the rings until the current has been reversed.

Joining porcelain and glass. R. THILENIUS. Brit. 285,919, April 18, 1928. Porcelain and glass parts are connected together by melting, the glass being arranged to have a coefficient of expansion of not more than .000005 and the melting points of the glass and porcelain being approximately the same. For example, a glass tube may be fitted over a porcelain spigot and the overlapping parts may be heated to connect them by fusion. Gas or acetylene burners may be employed for heating the parts. The invention is applicable to making mercury rectifiers, vacuum tubes, and Röntgen tubes, which are formed of porcelain and the lead-in wires are passed through glass members. Glass inspection surfaces may be melted in porcelain tubes.

Electric insulators. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 286,270, April 25, 1928. To prevent electric discharge, due to dust over the surface of an insulator, such as a strain insulator or a spark plug, projecting quartz strips are embedded in the insulator surface so as to extend transversely to the potential gradient over the surface. A strain insulator comprises metallic members interlinked through insulating material. Projecting quartz rings are embedded in the cylindrical surface of the material. Modified constructions of the quartz rings comprise helical strips, staggered short strips, and staggered strips of length greater than a semi-circle.

Equipment and Apparatus

Cutting costs with new brushing table. ANON. *Ceram. Ind.*, **10** [5], 514–15 (1928).—The Roesch Enamel Co. with a specially constructed table has eliminated dust from its brushing department. The table is constructed of galvanized iron mounted on an angle-iron frame. It is built in 3 sections, each 8 x 6 ft. The top of the table is of sheet iron punctured with $^3/_{16}$-inch holes. Along the sides of the table are 12 square funnel shaped apertures. There are two of these to a section and each has an opening of 4 ft. x 6 in. at the top and slopes to a 4-inch duct at the bottom. The height of the funnel is about 2 feet. F.P.H.

Gravity conveyers cut costs. ANON. *Ceram. Ind.*, **10** [5], 516–17 (1928).—A gravity conveyer system in the storehouse of this plant has reduced the labor required by two men and the ware can be stored or handled for shipment in much less time than was heretofore required. F.P.H.

Monorail conveyers in pottery plant. ANON. *Ceram. Ind.*, **10** [5], 518–22 (1928).—The Morton (Ill.) Pottery Co. increased production considerably, cut down the labor item, and reduced breakage 15% by installing 1500 ft. of conveyers and 34 carriers having a capacity of 24 dozens each. This conveyer system is utilized to carry the leather-hard ware as it comes from the molds to the stillage which is located in a drying room 100 x 81 ft. This drying room can hold a week's supply of ware. The ware is placed in such a way that the same drying period is received by all. As required the

ware in the drier is placed on the carriers and moved direct to the kilns. The latter are fired to cone 02–04 in about 40 hours and each kiln will hold about 2000 saggers. Firing is done with oil and steam is used for atomizing the oil. F.P.H.

Pyrometer tubes and gas-sampling tubes. W. FUNK. *Feuerfest*, **4** [1], 1–3 (1928).—F. enumerates the requirements for pyrometer and gas-sampling tubes and describes the ideal tube. Very little information is given on the composition of such products. F.P.H.

Use of screening machines for determining the fineness of materials. ANON. *Tonind. Ztg.*, **51** [99], 1790–92; [100], 1815–18 (1927).—The sources of errors in screen analysis are discussed. Various machines that are used in carrying out screen analyses are illustrated and described. F.P.H.

Segregation in storage bins. C. E. BALES. *Clay-Worker*, **89** [5], 387 (1928); *Brick Clay Rec.*, **72** [10], 713–14 (1928).—For abstract see *Ceram. Abs.*, **7** [6], 384 (1928). E.J.V.

Temperature measurement of flowing gases. C. SCHWARZ. *Die Messtechnik*, **3** [7], 191–96 (1927).—The disagreement of early measurements of temperatures of flowing gases is pointed out. Reflection in thermo-elements with and without radiation protection is discussed. Descriptions are given of pyrometers permitting flow of gases through them, pyrometers permitting flow of gases having walls which can be heated, works instruments according to Wenzl, calorie pyrometers, and element heating. E.J.V.

Apparatus for measuring heat conductivity of dry insulating and building materials. J. S. CAMMERER. *Die Messtechnik*, **3** [9], 253–58 (1927).—A new laboratory apparatus for the determination of the heat conductivity of dry insulating and building materials, which is especially suitable for quick and inexpensive carrying out of tests for many technical purposes, is described. The results obtained so far are discussed. E.J.V.

Venturi stack for exhausting corrosive gases and fumes containing viscous materials. M. GLICKMAN. *Fuels and Fur.*, **6** [5], 677 (1928).—The use of apparatus based on the injector principle for discharging fumes from spraying cabinets has been employed in Europe for a number of years. The system consists of a vertical stack shaped like a Venturi tube and an injector nozzle. A pressure blower furnishes the "motive fluid" which is discharged through the nozzle. G. gives rules for the design of Venturi stack apparatus which give good results in practice although an adequate theory of Venturi stack action is lacking. A.E.R.W.

Steam accumulator. ANON. *Brit. Clayworker*, **37** [432], 14 (1928).—A description of Johannes Ruth's steam accumulator and how it may be used to advantage in the boiler plant of an establishment manufacturing clay products. R.A.H.

Precision polymeter. ANON. *Brit. Clayworker*, **37** [432], 14–15 (1928).—This instrument is a hygrometer for measuring the amount of moisture or water vapor in the air by direct reading. The polymeter replaces the present means in which the wet and dry bulb thermometers are used. The polymeter consists of a thermometer for reading the air temperature and the hygrometer with the segmental scale giving two readings by a special needle. The dewpoint or temperature at which the air would begin to precipitate moisture is calculated by two means: (1) by deducting the reading of the upper scale from the reading of the thermometer; (2) at a given temperature of the thermometer, a definite vapor pressure at saturation is indicated by the right-hand scale of the indicator and the per cent of moisture on the lower scale is also indicated. By a simple calculation the temperature of the dewpoint is obtained. The instrument is of value to the brick manufacturer, both to the seasonal maker, who dries the brick in the open air and to the user of artificial drying systems such as tunnel and humidity driers. The instrument is made by C. A. Ulbrich & Co., Zurich, Switzerland. R.A.H.

Thermal conductivity standards. ANON. Bur. Stand., *Tech. News Bull.*, No. 132, p. 50 (1928).—As part of a coöperative program with the Celotex Co., an attempt is being made by the Bureau to determine the accuracy which can be expected from the various devices now in use for measuring thermal conductivity. A number of test specimens have been prepared which may be termed "thermal conductivity standards," and these are being furnished to the various institutions possessing "hot plate" conductivity apparatus. The test specimens consist of slabs of homogeneous cork composition material 8 or 12 inches square to the surfaces of which thermocouples are permanently fastened, so that the boards are in reality "conductimeters" or "heat meters." R.A.H.

Base plates for Emley plasticimeter. ANON. Bur. Stand., *Tech. News Bull.*, No. 132, pp. 53–54 (1928).—An unglazed porcelain plate 4 in. in diameter and 1 in. thick is used to simulate the actions with reference to absorption of the scratch and brown coats of plaster. The rate of absorption of the plate influences to a marked degree the "plasticity figure" of the lime. After considerable difficulty the Bureau, in coöperation with the makers of the plasticimeter, has succeeded in obtaining an unlimited supply of plates which have the proper absorption characteristics. R.A.H.

Methods for measurement of high temperatures. H. STÜMBKE. *Keram. Rund.*, **36,** 83–86 (1928).—Pyrometric cones, thermo-elements and resistance, radiation and optical pyrometers are described briefly. H.I.

Chromium plating as an aid to industry. D. H. KILLEFER. *Ind. Eng. Chem.*, **19** [7], 773–76 (1928).—Chromium is now being applied electrolytically to many bases. It is of value because of its resistance to tarnish, its hardness, resistance to oxidation at high temperatures, to sulphur compounds in petroleum, and to a number of other corrosive agents. A typical plating solution is mentioned and many industrial applications of chromium plate are enumerated. R.J.P.

Rotameters in industry. F. C. SUTTON. *Glass*, **4** [3], 117 (1927).—The rotameter is a precision flow meter for fluids, both liquid and gaseous. It consists of a tapered glass tube within which a top-shaped float is maintained in rotating suspension by the upward flow of the fluid through the tube, the rotary movement being due to small inclined slots cut round the rim of the float. This rotating action maintains the float exactly in the middle of the tube thus avoiding any possibility of friction and consequent inaccuracies and also insures that the float will rotate smoothly about its medial axis and maintain a steady horizontal position for a given fluid flow. Thus it is a simple matter to obtain an accurate reading by taking the coincidence of the top line of the float with the calibration marks etched on the tube. The readings being accurate to within 2%, the rotameter is equal to the best precision meters and the instrument has the peculiarity that the readings are uniformly accurate throughout the entire scale range. These flow meters are made in many sizes and types from the minute laboratory research instrument up to those for mains 6 feet in diameter. There are many possibilities for the use of these in the glass industry. A.J.M.

Measurement of light out-of-doors: ecophotometry. A. B. KLUGH. Nat. Res. Council of Canada, *Ann. Report*, **10,** 73 (1928).—The measurement of light intensity in the laboratory and in the field are quite different problems. In field work, portability of instruments is a first essential, and wide ranges of measurement and quickness of reading are of importance. The light from a clear blue sky at noon and that from the setting sun may be equal in intensity, but they differ radically in character. An ecophotometer was evolved and proved satisfactory. It consists of a wedge-shaped strip of gelatin stained with a neutral dye and placed between two strips of optical glass, with a gradient of 1–0.01. The light passing through the wedge falls on special photo-

graphic paper, and the intensity is measured by comparison with standards. The apparatus is mounted in a duralumin case. H.H.S.

Efficiency of screening. J. B. PORTER. Nat. Res. Council Canada, *Ann. Report*, **10**, 95 (1928).—The first part of the research investigated the blinding of screens by difficult grains. Considerable light was thrown upon the proper design of mechanically vibrated screens. The Warner theory of difficult grains is not accepted. The second series of tests was planned to determine the relation between screen capacity and particle size. From theoretical considerations, a greater weight of large particles should pass through large openings in a minute than small particles through small holes. No straight-line relation was found, however. Irregularities occurred, depending upon the nature of the sample. H.H.S.

BOOK

Diesel Engines, Theory, Construction, Problems. JULIUS MAGG. Berlin, V. D. I. Verlag, 1928. 278 pp. Illustrated. Price 26RM. Reviewed in *Min. and Met.*, **9** [256], 203 (1928).—The aim of this book is to provide a general survey of our knowledge of the theory and construction of the Diesel engine, and of the trend of future development, which will be as concise as possible and yet be reasonably full and comprehensive in scope. The first section presents the fundamental principles of the engine, treating of its thermodynamics and thermometry, the calculation of the principal dimensions, its fuels, and its economy and power. The second section discusses design. It describes and illustrates the various types, presenting numerous models that have not been published previously. Chapters are devoted to locomotives, automobiles, and ship propulsion. F.P.H.

PATENTS

Thermostat. ROBERT F. MASSA. U. S. 16,940, April 24, 1928 (Re-issue). In an automatic temperature controlling device the combination of a flexible, elastic thermostatic member, rigidly fastened at one point, an armature carried on the thermostatic member at another point, a magnetic field of varied intensity located within the line of travel of the armature when moved by the effect of varying temperature on the thermostatic member, a contact member located near the point of greatest intensity of the field and a coöperating contact member carried by the thermostatic member.

Thermostat. JOHN E. BOLLING. U. S. 1,666,192, April 17, 1928. In a device of the class described, the combination with control means for temperature regulating equipment, of a support, an expansion element on said support, a yoke carried by the expansion element so as to be actuated thereby, a spring arranged to resist expansion of the element, and a stop for limiting the expansion of the element, the spring and stop being adjustable for varying the range of movement of the element which is arranged to immediately actuate the control means upon a reversal in the direction of movement of the element.

Grinding machine. OTTO SANN. U. S. 1,666,313, April 17, 1928. In a machine for cutting curved or arcuate grooves or paths in a work-piece, a stationary base member, a bed slidably mounted on the base and adapted to be reciprocated longitudinally thereof, a work supporting table mounted on the bed, the table being pivotally connected to the bed adjacent one end and slidably supported on the bed adjacent the other end whereby the table may be swung about the pivot transversely of the bed, a tool mounted above the table, a guide rail extending along one side of and longitudinally of the bed and arranged at an angle to the longitudinal axis of the bed, a bracket arm for supporting the guide rail, the bracket arm having one end fixedly secured to the guide rail intermediate its ends and having its other end pivotally mounted on a fixed pivot pin whose center line intersects the longitudinal center line or axis of the bed, means for moving the rail about the pivotal mounting of the bracket arm, means for locking the rail in

adjusted positions, and a guide arm mounted to travel along the rail, the arm being pivotally connected to the table at a point spaced from the slidably supported end of the table a distance equal to the distance the pivotal mounting of the table is from the opposite end of the table, whereby the table will be swung transversely of the bed as the bed and table are reciprocated longitudinally so as to cause the tool to cut an arcuate path in the work-piece carried by the table.

Electrical safety control circuit for automatic burner equipment. FRANK FISCHER. U. S. 1,666,331, April 17, 1928. In an electrical control circuit for burners having gas ignition pilots, a fuel-supply motor, a heat-requiring conductor, the conductor being located adjacent to the pilot so as to be heated and thereby rendered conductive by the pilot when the pilot is ignited, the conductor being connected in series with the motor so that the motor cannot start when the pilot is not ignited, the conductor being so proportioned as to be heated by current passing through it and thereby maintained in a conductive state independently of the pilot when the motor and conductor are energized so that the motor will continue to run if the pilot goes out while the motor and conductor are energized.

Air classifier. ALBERT H. STEBBINS. U. S. 1,666,476, April 17, 1928. A spiral classifier, comprising in combination, a vertically disposed pipe having air inlet openings in its walls, a closed casing wound spirally around the pipe to communicate with the openings and constructed to form a spiral classifying chamber, an apertured floor-plate for the casing extending spirally around the central pipe and constructed so that the materials to be treated will slide down the floor-plate, means for delivering the materials to be treated to the upper end of the spiral casing, and means for exhausting air from the pipe to draw air into the spiral chamber through the apertures in the floor plate and from the chamber into the central pipe to cause the air to pick up and carry into the central pipe the lighter particles traveling along the floor-plate.

Air classifier. ALBERT H. STEBBINS. U. S. 1,666,477, April 17, 1928. An air classifier, comprising in combination, a long annular receptacle supported in an upright position and having a length that far exceeds its diameter, a fan rotatably mounted in the receptacle and having fan blades that extend throughout approximately the entire length of the long receptacle, means for producing rising air currents within the receptacle, means for delivering the materials to be treated into the receptacle so that the lighter particles will be picked up by the air, and means for rotating the fan to impart a rotative movement to the volume of air within the receptacle which will serve to throw the heavier particles outwardly by centrifugal force throughout the length of the receptacle and keep them close to the walls of the receptacle as they move downwardly therein.

Underfeed stoker. ANTHONY F. SCHWENDNER. U. S. 1,666,512, April 17, 1928. A mechanical movement comprising an operating arm, a connecting link, means on the operating arm for engaging the connecting link which has a plurality of notches for receiving the engaging means, means biasing the connecting link so that its notches tend to be out of engagement with the engaging means and means for positively holding the link during at least a portion of the stroke so that the operation arm engages one of the notches.

Thermoelectric transformer. JOHN H. STEURER. U. S. 1,666,919, April 24, 1928. In a thermoelectric transformer, the combination with a plurality of thermoelectric couples connected in series, and provided with two series of junctions located in two separated lines substantially parallel to each other, of an electric heating element located in close proximity to but electrically insulated from one line of junctions, the other line of junctions and the portions of the couples adjacent thereto being exposed to the atmosphere to facilitate radiation, and a terminal voltage regulating device in circuit

with certain couples constructed to vary the heating circuit through the heating element in accordance with variations in the voltage generated in the couples connected therewith, and maintain a substantially constant terminal voltage in all of the couples.

Thermocouple. WILLIAM A. DARRAH. U. S. 1,667,142, April 24, 1928. A thermoelectric couple consisting of two metals of granular form interlocked with an insulating support.

Stoker and the like. WILBURT WARD. U. S. 1,667,230, April 24, 1928. A stoker comprising in combination, an oscillating feeder, driving means for the feeder comprising a pivoted arm, a block slidable on the arm, a link connected to the feeder and the block, means to preserve the position of the block on the arm during normal operation of the feeder, the last-named means yielding to permit the block to slide when the feeder is stalled during oscillation of the arm and means to oscillate the arm.

Cleaning and sizing apparatus. EDWARD O'TOOLE. U. S. 1,667,331, April 24, 1928. A sizing and cleaning apparatus for coal and the like comprising, in combination, a sizing screen and a cleaning table, a wind box connected to the under-side of the table, a fan having its blowing port connected to the box, a hood over the table adapted to receive the air blown upwardly through the table from the wind box, a wind box under the screen, means connecting the hood over the table with the wind box under the screen, a closed passage above the screen and connected to the upper side of the table through which the screened coal is delivered to the table and into which air passing upwardly through the screen is trapped, means for preventing the free passage of air from the table through the closed passage, and a conduit connecting the closed passage to the intake port of the fan whereby a suction is created in the closed passag above the screen and the hood above the table and the air passing upwardly through the screen is returned to the fan.

Colorimeter. ROBERT E. KLETT. U. S. 1,667,478, April 24, 1928. In a colorimeter, the combination with color observing means for standard and test solutions, of color intensity indicating means for each of the solutions, means carried by the colorimeter for indicating the relation between intensities of colors, and means adjacent the first mentioned means for observing the last two mentioned means.

Apparatus for spraying plastic or comminuted materials. JOHN RODNEY MACK. U. S. 1,668,080, May 1, 1928. A portable gun for handling plastic materials which comprises, in combination, a tank having a reëntrant portion in one side wall, an ejector apparatus mounted and practically enclosed in the cavity so formed, a suction connection from said injector extending down through the lower wall of the cavity nearly to the bottom of the tank interior, and a supporting carrier for the tank having parts closely embracing the side walls thereof, adjacent the ejector apparatus.

Rotary screen. JOSEPH A. WHITE. U. S. 1,668,579, May 8, 1928. The combination of a vat, a rotating screen mounted within the vat, rockers on each side of the vat, perforated plates carried by the rockers and located between the screen and the vat, a connecting rod extending under the vat and attached to the rockers on each side thereof, and means for imparting movement to the rockers.

Thermostatic regulator. AUGUST J. MOTILAU. U. S. 1,668,973, May 8, 1928. In a thermostat, an apertured frame composed of layers of material having different coefficients of expansion, the frame being so shaped that in its normal position it is slightly concave on the side having the material possessing the higher coefficient of expansion, and a bridging member spanning the aperture and having an effective length greater than the length of the aperture, the center of mass thereof normally being disposed at one side of the central plane of the frame, and moving its center of mass across the central plane of the frame with a snap action after a predetermined expansion of the initially concaved material by reason of changes in its thermal condition.

Conveyer equipment. JULIAN M. LIVINGSTON. U. S. 1,669,060, May 8, 1928. A conveyer mechanism consisting of a series of table members carried by parallel pin members and pivoted and supported at diagonally opposite corners, a series of link members forming a supporting chain on each side of the table members, the link members being staggered with respect to the corresponding link members in the opposite chain, a series of pairs of sprockets coacting with the chains, each sprocket of each pair being mounted on an independent axis displaced in a horizontal plane from the axis of the other sprocket of the same pair.

Filter plate. HAROLD L. WATSON. U. S. 1,669,362, May 8, 1928. A cellular body comprising particles of silica adhering to one another in the absence of a binder, the particles being individually expanded into an intumescent condition resembling puffed grain.

Cellular silica product and method of fabrication. HAROLD L. WATSON. U. S. 1,669,363, May 8, 1928. The method of preparing highly porous silica which consists in heating crystalline silica to about 1700°C, cooling to a temperature below about 230°C, impregnating with a decomposable binder and reheating rapidly to about 1750°C.

Nozzle. ESHELBY F. LUNKEN. U. S. 1,669,419, May 15, 1928. In a nozzle, the combination with a valve-containing body having a threaded nozzle therein, and having a projecting valve stem, whereby the valve is operated, a resilient lever for operating the valves, the lever held in place on the body by the nozzle.

Boring tool. CARL H. SCHMIDGALL. U. S. 1,669,423, May 15, 1928. A boring tool including a substantially flat body having a series of openings extending through it from side to side disposed in even spaced relation, a pinion in each opening, a separate shaft for each pinion, two of them being in line with the longitudinal axis of the body and one of them extending out through the body at its narrow side acting as a drive shaft, two of the other shafts lying at right angles to the axis of the drive shaft extending from the edges of the body, a cutter on the outer end of each, and a gear at each flat side of the body in mesh with the several pinions, each including a cutter.

Mounting for rock drills. CHARLES C. HANSEN. U. S. 1,669,466, May 15, 1928. A mounting for a plurality of rock drills, comprising in combination with cylinders having lateral projections, a carriage, bearings on the carriage to support the drills, and a common clamping means pressing on the projections to hold the drills against movement with respect to the carriage.

Conveying apparatus. RICHARD LA FRANCE. U. S. 1,669,474, May 15, 1927. The combination with a traveling belt conveyer, of a plurality of stationary guides extending lengthwise of the conveyer and arranged to provide individual guideways along which articles on the conveyer are guided and held out of contact with each other, and tensioning devices for the guides.

Thermal control device. CHRISTIAN AALBORG. U. S. 1,669,544, May 15, 1928. A unitary heater controller of the bayonet type comprising a casing having a portion adapted to be inserted in a heat-storage receptacle, to be subjected to the heat therein, a thermal responsive element disposed in the portion, a supporting and adjusting means for the thermal responsive member mounted on the portion, a supporting bracket supported by the encasing portion, a switch and an operating means therefor controlled by the thermal responsive means and disposed on the supporting bracket, and a cover member removably mounted on the casing for enclosing the thermally responsive element, supporting and adjusting means, supporting bracket, switch and operating means therein.

Pneumatic mechanism for handling sheets. PAUL A. GOLLNICK AND JOHN J. TOOLAN. U. S. 1,669,556, May 15, 1928. A device of the class described comprising

a member having a foraminous surface for supporting sheets, a vacuum chamber communicating with the orifices of the surface, and a single valve controlling the communication and arranged to break the vacuum at a certain area of the supporting surface independently of other areas communicating with the chamber.

Conveyer. CLARENCE R. CLAGHORN. U. S. 1,669,590, May 15, 1928. A conveyer comprising relatively pivotally mounted trough sections, and means fastened to one of such sections and connected to the other for effecting relative pivotal movement therebetween.

Conveyer belt. JESSE W. GREER. U. S. 1,669,613, May 15, 1928. A conveyer belt, comprising in combination a pair of endless chains supported in spaced relation to each other, sprockets for driving the chains, a series of flexible belt sections, bars secured to the ends of these sections, means for pivotally securing the ends of the bars to the side chains to support and advance the sections, drums mounted between the spaced chains at the ends of a run thereof to support the belt sections as they pass from one run of the chains to the other, one of the drums being formed of spaced rods extending axially of the drum to form a skeleton drum construction which will prevent the material being conveyed from accumulating upon its belt engaging surface and spaced bands extending around this skeleton drum over the rods to form a smooth belt supporting surface and each band having its ends spaced to provide a bar receiving gap and having its ends secured to adjacent rods.

Molding apparatus. JOHN R. GAMMETER. U. S. 1,669,704, May 15, 1928. Molding apparatus comprising a pair of spaced-apart, stationarily-mounted platens defining a mold-receiving space and a mold adapted to seat in the space, the mold consisting of two mating mold sections constituting a substantially complete enclosure of a mold cavity.

Conveyer for heat-treating furnaces. ARTHUR T. KATHNER. U. S. 1,669,903, May 15, 1928. In a conveyer for heat-treating furnaces, a tubular shaft of substantially uniform diameter throughout, and means closing the ends of the shaft which is devoid of perforations except in the portions of the ends thereof which are received by the furnace walls, the perforations of the end portions constituting vents through which heat is discharged into direct contact with the furnace walls for heating the latter.

Variable spray device. ISAAC W. P. BUCHANAN. U. S. 1,670,235, May 15, 1928. (1) A continuous variable hand operated spraying device, comprising a container, a hollow head thereon and communicating therewith, a hand operated air compressing pump rigidly connected with the head for introducing compressed air into the head and container and for manipulating the spraying device when in use, an eduction tube having one end connected to and in communication with the hollow head, a liquid tube open at both ends extending through the eduction tube with its outer end protruding from the eduction tube and having its inner end portion depending into the container, the delivery end portion of the liquid tube being circumferentially spaced from the delivery end portion of the eduction tube to form an annular unobstructed air outlet passage, means for immovably fixing the liquid tube relative to the eduction tube, thereby holding its protruding end in fixed relation to the outer end of the eduction tube, an atomizing tip adjustably mounted on the outer end of the eduction tube so that it can be moved into sealing engagement with the outer end of the liquid tube or held in spaced relation thereto, thereby wholly or partially preventing compressed air from the eduction tube from contacting the emerging liquid, and the aperture in the tip being smaller than the outlet from the liquid tube, thereby causing, with the adjustment of the tip, a varying back pressure on the emerging liquid, and means for stabilizing the atomizing tip in its successive positions on the eduction tube and preventing the escape of air and liquid except through the aperture. (2) A continuous variable hand operated spraying device,

comprising a container, a hollow head thereon and communicating therewith, a hand operated air compressing pump rigidly connected with the head for introducing compressed air into the head and container and for manipulating the spraying device when in use, an eduction tube having one end threadedly connected into the head and in communication with the hollow head, a liquid tube open at both ends extending through the eduction tube and having its inner end portion depending into the container, the delivery end portion of the liquid tube being circumferentially spaced from the delivery end portion of the eduction tube to form an annular unobstructed air outlet passage, the threaded end of the eduction tube comprising adjustable means for immovably clamping the liquid tube against a portion of the head, thereby holding its protruding end in fixed relation to the outer end of the eduction tube, an atomizing tip adjustably mounted on the outer end of the eduction tube so that it can be moved into sealing engagement with the outer end of the liquid tube or held in spaced relation thereto, thereby wholly or partially preventing compressed air from the eduction tube from contacting the emerging liquid, and the aperture in the tip being smaller than the outlet from the liquid tube, thereby causing, with the adjustment of the tip, a varying back pressure on the emerging liquid, and means for stabilizing the atomizing tip in its successive positions on the eduction tube and preventing the escape of air and liquid except through the aperture.

Rotary pumps, fans, and motors. E. S. G. Rees. Brit. 285,531, April 12, 1928. The blades of a rotary pump or fan have spirally disposed blades with a thickened edge which curves back from the boss against the direction of rotation and the blades are of increasing depth from the front for a distance, then uniform, and the rear part is again of increasing depth while the pitch diminishes over this rear part. For a pump a casing is used with a large inlet chamber, and at the delivery end there is a ring of deflector blades. Means for supplying air at the region of lowest pressure is provided for preventing cavitation. The impeller has spirally wound blades curving backwardly and the depth of the blades increases toward the middle and is constant toward the discharge, the edge being thickened. It is mounted in a casing, with a large capacity inlet, with deflector delivery blades, and with an expanding delivery chamber formed between the outer part and conical boss. A by-pass connects the inlet with the hollow cone whereby air may pass between the fuel and rotary blades. A sealing ring is used to cover the gap between the two sets of blades. In a modification the outer edges of the blades sweep a cylindrical surface and the boss has a configuration which gives the required variation in depth of blade. The axial delivery chamber may be replaced by one of volute form, the stream being discharged outwardly. Only parts of the blades may be cast with the boss, the remaining parts together with intermediate blades being cast on a ring which is secured to the boss. The bulbous edge may be hollow, the duct therein communicating through the hollow boss with a duct on the driving shaft, this duct having a valve which opens at a given pressure to admit air.

Conveyers. Mavor and Coulson, Ltd. and J. Thomson. Brit. 285,627, April 18, 1928. The lower run of an endless belt conveyer is protected by a casing in the form of an inverted trough. The casing is made in sections arranged end to end with a space between adjacent ends in which are located the supporting rollers. Adjacent sections are connected by a top plate and side plates in the latter of which are formed the bearings for the rollers. The sections are supported by pedestals.

Grinding, crushing, etc. D. C. Addicks. Brit. 285,754, April 18, 1928. In a disintegrating-machine comprising a crushing chamber with a grating at the lower part and containing a rotor coöperating with a breaker plate, a pendant hinged plate forms a movable bottom for the feed hopper and feeding means comprising a moving plate is positioned between the movable bottom and the breaker plate, the lower end of the moving plate having reciprocating movement on the breaker plate and sliding contact

with the movable bottom. The rotor in the crushing-chamber consists of a series of disks mounted on a shaft and carrying hinged hammers, and the feeding-plate, positioned between the breaker plate and a plate hinged at its upper end on a transverse rod in the upper part of the hopper, is mounted at its upper end upon a crank on a shaft driven by gearing from a shaft driven from the driving shaft. A shoe on the lower end of the plate has its outer portion tapered to a sharp edge to bear upon the plate, and the lower end of the plate bears upon the plate adjacent its lower end. On its downward movement, the plate scrapes the breaker plate and on its upward movement its upper surface is scraped by the plate. The invention is particularly applicable in the treatment of wet or sticky materials.

Colorimeters. R. A. LEGENDRE. Brit. 285,848, April 18, 1928. In a colorimeter of the type in which the sighting system permits of two separate sighting lines being obtained, the tank or reservoir system comprises two units each having three tanks with transparent walls. The tanks are so constructed that the thicknesses of liquid traversed by the lines of sight remains constant for one tank as it is moved across the line of sight and varies in opposite directions for the 2nd and 3rd tanks, the sum of the thickness of the last 2 remaining constant. The thicknesses of liquid traversed in the 2 units are the same at each instant. In one example, the units consist of a tank of uniform thickness, a 2nd tank, and a 3rd tank, these two latter tanks being in the form of right-angled triangular prisms oppositely arranged. The 2 units are placed together and illuminated by beams from a source reflected from mirrors; observation being made by means of an eyepiece and a Pulfrich prism. In another example, the units comprise tanks having cylindrical vertical transparent walls, the tanks of greatest and least diameter being coaxial and the 3rd eccentric. The tanks are illuminated through the hollow axis upon which they rotate and are viewed in a similar manner to that of the first example.

Sand-blast nozzles. J. JACOBOVICS AND F. NASSAU. Brit. 285,883, April 18, 1928. A sand-blast nozzle consists of an inner lining comprising one or more members made of tungsten carbide or material of similar hardness and surrounded by a jacket made of soft material such as lead, tombac, brass, soft iron, fibrous material, leather, rubber, etc. If a metal jacket is employed, the metal is preferably of low melting point so that the jacket may be replaced by a casting operation. The hose may be connected to the jacket by a clamping ring. The lining may have a plane end surface at the entry end of the nozzle. Protective ribs may be provided on the jacket, or an outer jacket o stronger material such as seamless tubing may be employed.

Burner apparatus. E. C. R. MARKS. Brit. 285,974, April 18, 1928. In an oil fuel burning apparatus of the type in which the fuel and air projecting means are driven by an electric motor controlled by a room thermostat arranged in a secondary circuit, a normally closed shunt from the secondary circuit maintains a safety switch closed under normal working conditions. In abnormal conditions the shunt circuit is broken and the safety switch then operates to effect the interruption of the motor circuit. The burner apparatus comprises an electric motor operating a rotary atomizer to supply a mixture of fuel and air to a nozzle discharging into a combustion chamber. The motor also drives a fan supplying air to the combustion chamber through a housing and a pump supplying fuel to the atomizing chamber through a strainer. A diaphragm member in a casing is moved upwardly by the pressure in the atomizing chamber when the motor starts and raises a lever against the resistance of a dashpot, thereby opening the fuel valve of the atomizing chamber and a gas valve of a pilot light adjacent the burner nozzle. The pilot light is ignited by sparks from a coil which is energized by the lever engaging with a knife switch during its movement. At the completion of the movement of the lever its pivoted end snaps over the stem of the gas valve and allows the valve to close. The main switch comprises a pivoted armature adapted to make or break

at the contact the main circuit to the motor when one of two opposed electromagnets is energized from the secondary circuit of the transformer on the movable arm of the thermostat mak ng contact with the "on" or "off" contact points. A spring switch operated by the armature causes the secondary circuit to be completed only momentarily to effect the movement of the armature. In the "common" supply lead to the thermostat is arranged a safety switch which is normally maintained in engagement with a contact to close the secondary circuit by an electromagnet. The electromagnet is energized by a circuit arranged as a shunt to the secondary circuit through the thermostat. In the normal operation of the burner the circuit is completed while the burner is alight by a mercury switch operated by the expansion of air in a chamber subjected to the heat of the flame and while the burner is out by the engagement of the lever with the knife switch. During normal ignition the dashpot delays the break of the circuit at the knife switch until the mercury switch is closed by the heat of the flame. Should however the ignition of the burner fail either initially or subsequently the circuit through the electromagnet will be broken and a spring will move the switch from engagement with the one contact into engagement with the other contact thereby completing a circuit through the electromagnet and stopping the motor until the switch has been reset by hand. In a modified form of apparatus the breaking of the circuit through the electromagnet releases a weighted lever operating the armature.

Chain conveyers and moving platforms. T. M. CAMPBELL. Brit. 286,040, April 18, 1928. A chain conveyer is adapted to move in a curved, sinuous, or spiral path by providing the chain with alternate links and link pins at right angles to one another, each set of links carrying roller shafts engaging two pairs of roller guideways arranged at right angles, thus restraining both vertical and horizontal movement of the chain. In the illustrated form the split ends of the chain are provided with 2 holes, one for the vertical or horizontal link pins respectively, and the other for the respective roller shafts, the one set of rollers running in channelled guides and the other set running between the two guides. The load carriers are formed by depending pockets to receive articles such as bottles, suspended from extensions of the horizontal links.

Conveyers. J. BLADES. Brit. 286,190, April 25, 1928. A loading table constructed and arranged to assume a loading position inclined to the conveyer is adapted to swing round to form a continuation of the conveyer so that goods pass from it unaided on to the conveyer. An unloading table normally forms a continuation of the conveyer, but is tipped by the weight of the goods into the position shown, which is suitable for the manual removal of sacked goods, or until arrested by a plate in which position the goods are thrown off automatically. Each table is provided with rollers and with a pair of pivot bars in order that it may be used at either end of the conveyer. The end boards are detachable and may be attached to either end of a table.

Electric heating apparatus. W. DOHT, W. NAUCK, AND A. SCHMIDTPREDARI. Brit. 286,437, April 25, 1928. A resistance wire is compressed between two slabs of wood or artificial wood rendered fire-resisting. Preferably the wire is forced into the slabs by pressure, but the slabs may be grooved for its reception if necessary. The heater may be treated with water glass or other composition to close the pores of the wood. The wire may be bare or insulated. Sheets of mica or like insulating material may be placed on each side of the wire, or the wire may be sewn on to a sheet of insulating material and the whole placed between the slabs. A heater is shown in which wire is disposed in a zig-zag, holes being formed in the slabs to increase the radiating surface

Kilns, Furnaces, Fuels, and Combustion

Manufacture of producer gas. J. V. POSTLES. *Ceram. Age*, **11** [4], 135–37 (1928).—Gas producers are used extensively for the production of an economical, low grade,

gaseous heating medium. The method of manufacture has become so simplified that little labor is demanded in the process. While water gas is manufactured in two steps, producer gas is manufactured continuously, both steps being combined into one. Steam and air are passed through the hot fuel bed in such proportions as to keep the temperature of the bed constant. P. describes in detail the different types of producers used in making producer gas, compares producer gas with blue gas and natural gas, and gives analyses, reaction temperatures, B.t.u. values, etc. Illustrated. A.E.R.W.

New type sheet normalizing furnaces. C. P. MILLS. *Fuels and Fur.*, **6** [5], 603–606 (1928).—M. describes two furnaces of special construction at the Newton Steel Co., equipped with special insulated disk rollers and arranged for burning gas or oil. They are used to normalize steel sheet. Fireclay brick, fire clay, Superex, and other ceramic insulating materials were used in the construction. A.E.R.W.

Continuous melting glass furnace recuperator. ANON. *Fuels and Fur.*, **6** [5], 654 (1928).—A brief illustrated description is given of a natural draft recuperator recently installed in a 3-ton continuous glass melting furnace producing heat resisting glass at a furnace temperature of 2800°F. Its use has resulted in improvements in both combustion and operating conditions. A.E.R.W.

Possibilities of the electric kiln. ANON. *Ceram. Ind.*, **10** [5], 523–24 (1928); abstracted from *Electrical Times*.—Experiences of the Minton Pottery (England) with an electric kiln installation are related. In this installation slight modifications have been made. The length of the tunnel was shortened by 2 ft. and the time taken to transverse the kiln is approximately 18 hrs. The heating elements in this kiln are confined to the firing zone, which occupies about $^1/_3$ the total length of the tunnel in the center. The nickel-chromium ribbons radiate heat directly on to the ware as the trucks pass through the firing zone. The electricity supply is 3-phase (415 and 240 volts) and the load is balanced; the total load being 40 kw. Automatic temperature control equipment is used on this kiln and the regulation is not effected on the whole load but on a 3-phase section corresponding to about $^1/_4$ of the full load. The main group of heaters is kept in circuit continuously while the furnace is in operation, an arrangement that has, of course, a favorable effect on the steadiness of the load. For different firing purposes, temperatures of 700–820°C are required, but rarely anything above the latter temperature. The maximum temperature range for the resistance used in the furnace is close to 1000°C. When trucks are loaded or removed from the kiln, the charging and discharging zones are cut off by baffle plates to prevent any undue loss of heat. In order to conserve heat as much as possible the kiln for most of its length is very heavily insulated. The loss of heat from the kiln is so small that artificial heating is required in the room to keep the operators warm. F.P.H.

Rotary kiln and its operation. SCHUSTER. *Chemiker-Ztg.*, **667**, 708 (1927); *Rock Prod.*, **31** [9], 82–83 (1928).—The regular feeding of the raw material into the rotary kiln is one of the most important parts of such a process; should irregularities occur, most unsatisfactory results follow. If the amount of raw material fed is in less than normal, or the feed is suspended, a falling off of the production occurs, and there is the danger of overheating because of the decrease in material passing through the combustion zone, thus affecting the process unfavorably. The mixture can, for example, liquefy or adhere to the walls of the kiln. On the other hand, if the addition of the material to the kiln is too rapid, too much material comes into the furnace per unit of time, it is cooled too quickly, the mass is not heated sufficiently and the temperature at which the maximum yield is obtained is not reached, especially in processes which absorb heat, as is usually the case. Small variations in the feeding have a very slight effect upon the yield since the kiln itself brings about a certain adjustment before the material arrives at the combustion and sintering zone. An accidental break in the feeding, short of

duration, does not signify an absolute cessation, but merely a slower filling of the furnace, since the pushing forward of the farther mass ceases. When feeding is resumed, this material progresses somewhat more quickly so that equalization is obtained within certain limits. It is advantageous to have the raw material flow from a larger stock bin into a smaller one which can be thoroughly supervised by the foreman; from here it is led by some kind of a delivery tube into the kiln. This delivery contrivance must be capable of thorough regulation; the usual baffles for changing the number of turns do not suffice for delicate operations. A more sensitive means of regulation must be provided. It has been frequently observed that material well mixed in the stock bin later separated again. The wet process did not materialize the hope for advantages, therefore, with respect to a uniform mixing, and the regulation by means of a sludge valve was no more exact than a dry delivery. The maintenance of a constant degree of thickness in the sludge also offered decided difficulties. In manufacturing with dry materials, it is of considerable advantage to insert after the delivery arrangement a piece of apparatus in which the material is so thoroughly moistened that it no longer gives rise to a powder when it falls into the kiln, for otherwise a considerable amount would be carried by the flue gases into the dust chamber and flue. It is desirable to reduce to a minimum the amount of powdered raw material entering the dust chamber. Water, therefore, is squirted up with a sprinkler in the dampening coil or drum, either with or without a stirrer. It is necessary to keep the path from stock bin to kiln short; as a result the supervision is easier and the regulation better. F.P.H.

Electric furnaces for tempering, annealing, and enameling. H. NATHUSIUS. *Feuerfest*, **4** [1], 3–5 (1928).—N. discusses the following subjects: (1) construction of the electrical resistance furnace, (2) differences in the construction of electrical furnaces and furnaces heated by means of combustibles, (3) building material used in the construction of electrical resistance furnaces, (4) advantages of the electrical furnaces over those heated by means of combustibles. F.P.H.

Furnaces heated with illuminating gas. A. J. SMITH. *Feuerfest*, **4** [1], 16 (1928); *Forging, Stamping, Heat Treating*, **13**, 403–404 (1927). F.P.H.

Design of the Siemens-Martin furnace. D. E. LUBOJATZKY. *Feuerfest*, **4** [2], 20–23 (1928).—General directions are given for the design of the various parts of the Siemens-Martin furnace. F.P.H.

Automatic temperature regulators for gas firing. JOHN H. D. BLANKE. *Gas Age-Rec.*, **61** [5], 151–52 (1928).—Various types of automatic temperature regulators are described and illustrated. F.P.H.

Distribution of elements in coal carbonization. FRED M. REITER. *Gas Age-Rec.*, **61** [6], 175–76 (1928).—One of the interesting studies of the carbonization process is the distribution of elements throughout the distillation of the coal. The tracing of these elements and compounds through the products gives results that are almost mathematical in calculating the analysis, quantity, etc., from a primary distribution of the elements. F.P.H.

Cold-blast iron proposed for low temperature carbonization retorts. ANON. *Gas Age-Rec.*, **61** [6], 184 (1928).—In connection with low temperature carbonization at 900–1200°F of bituminous coal, shale, cannel, torbanite, and other material, there has long been a difference of opinion as to the merits of cast iron and fire clay for retort construction. This is an echo of 1830–1850 in the gas industry when a cast-iron *vs.* fireclay controversy for ordinary horizontal intermittent retorts was raging, especially in England. In carrying out the operation of low-temperature carbonization, the advantages of cast iron, especially at temperatures not over 1000°F, are numerous, and include a much better rate of heat transmission, ease of making any desired shape in offtake pipes, manhole covers, and supporting rings. Cast iron is also air-tight and

gas-tight. This does not matter so much in gas-works or coke-oven practice, but in many sections of low-temperature carbonization, it is obviously a very serious defect because the gas may leak through the pores of the fire clay and burn in the combustion chamber. On the other hand, the objections to ordinary cast iron are that it has a great tendency to oxidize and scale off under continuous temperature of 1000°F, while also it possesses the highly objectionable property of "creeping," that is becoming permanently distorted in shape. F.P.H.

Gas temperatures and pressures in the coke-oven process. J. C. LITTLE. *Gas Age-Rec.*, **61** [9], 281 (1928).—A general straight line lay-out is given of the gas travel through an average coke-oven gas plant, showing the relative positions of the various apparatus from the start to the finish of the gas making. At the same time a tabulation showing the temperatures and pressures before and after each equipment with the charge resulting is made up. The apparatus is listed together with its function, as well as the medium contained therein to operate on the gas during its short passage therein, and the effect on the gas. F.P.H.

Gas from lignite. DAVID BROWNLIE. *Gas Age-Rec.*, **61** [11], 355–57 (1928).—Many attempts have been made to use lignite in gas manufacture, either alone or blended with coal, and naturally such methods are only of interest in areas where lignite is plentiful and bituminous coal relatively scarce. Very great attention, however, is now being concentrated in different countries upon the general subject of the utilization of lignite, whether by direct use as a fuel in the raw state particularly, for example, in power generation or by carbonization, including both low and high temperature methods. The general situation today in the world with regard to lignite, expressed in a few words, can be stated to be enormous developments in Germany, corresponding to a consumption of about 120,000,000 T. of raw lignite per annum, nearly all used either in the raw state or in the form of briquets made at high pressures without a binder, but with an important low temperature carbonization industry for raw lignite that has been centered mostly round the Halle (Saale) area since about 1850; experimental work on an extensive scale in Saskatchewan and Alberta in Canada and in North Dakota in the U. S.; and the definite commencement of a large scale commercial exploitation of the Morwell lignites in Australia, along with very much smaller uses of local lignite in various parts of the world, such as Romania, the Balkans generally, Malay States, the Congo in Africa, and French Cochin China. Also much important experimental work has been carried out on lignite in several areas in the U. S. apart from Dakota, particularly Arkansas and Texas. F.P.H.

New slag crushing and screening plant. D. W. YAMBERT. *Rock Prod.*, **31** [7], 46–55 (1928).—A description is given of the recently completed plant of the France Slag Co. F.P.H.

Old Danish tunnel kilns. ANON. *Tegel*, **17** [10], 105–106 (1927); *Tonind. Ztg.*, **51** [100], 1824 (1927). F.P.H.

Floor flues for uniform draft in downdraft kiln. ANON. *Brit. Clayworker*, **37** [432], 6–9 (1928).—The technical study in America of the construction of the bottom of the kiln, has led to the unanimous agreement that the T-shaped flue under the floor gives the most uniform results. The stalk of the T is the main flue leading to the chimney and acts solely in that capacity. It receives the smoke from the brick by way of the cross of the T, into which admission is provided from a number of channels at right angles to it. A diagram shows the principle of construction of the round downdraft kiln. The larger the kiln the nearer together the floor channels should be placed. In the smaller kiln they may be 18 in. apart and are $4\frac{1}{2}$ in. wide. In this type of construction the smoke at high temperature in the last stages of firing is able to heat up the whole of the floor to almost the firing temperature, so assisting to equalize the heat

in the bottom courses. The construction of the rectangular downdraft kiln is also shown in cross-section and floor work. Illustrations are given showing method of setting kilns for firing, and some discussion on firing is included. R.A.H.

Continuous kiln for firing pottery and other clay products. J. WILLIAMSON. *Brit. Clayworker*, **37** [432], 18–22 (1928).—This new kiln is of the tunnel type and differs in many respects from the usual type of tunnel kilns; it may be fired by gas, oil, or by coal, and is of the combined direct flame and muffle type. It is designed particularly for firing pottery. Instead of the flame traveling in a longitudinal direction, it takes a transverse course which may be either updraft or downdraft. The flame may also alternate from one side of the kiln to the other which results in uniformity of temperature. W. discusses the arrangement of the 4 zones in the kiln, *i.e.*, heating, equalizing, furnace, and cooling, and the function of each. Advantages of this type of firing are pointed out. R.A.H.

Kiln efficiency. H. P. KIMBELL. Univ. Toronto, *Engr. Res. Bull.*, No. 8 (Section No. 1), 34 pages (1928).—An investigation of the draft, temperature, and combustion conditions in commercial kilns firing brick. Comparison of efficiency of different kilns is difficult owing to the many variable factors affecting them. Some of these variables are (1) time of firing with respect to (*a*) fuel consumption, (*b*) turnover; (2) loss of heat in flue gases, (*a*) draft intensity, (*b*) composition of gases, (*c*) their temperature; (3) moisture content of ware; (4) amount of ware set; (5) clay; (6) fuel. Each of the variables affects the efficiency of firing; some must be maintained constant in order to determine the effect of the others. Of the four kilns studied, the efficiencies (taking Mellor's value for the specific heat of clay, $0.192+0.000033t$) were 23, 25.2, 19.9, and 22.7%, respectively, the first two kilns firing Ky. slack with forced draft, and the second two Pa. lump with natural draft sometimes augmented by a stack fan. Two sources of loss of heat were measured: the loss in the dry flue gas and the loss in water vapor. The first amounted to 26.4, 61.8, 23.6, and 46.7% respectively in the 4 kilns, and the second to 6.7, 6.0, 5.4, and 5.6% respectively. An average of 25% loss is assumed for the following 5 causes: unconsumed coal, unburnt gases, heat absorbed by kiln, heat radiated from kiln, heat given up by gases between kiln and stack. H.H.S.

Heating pot furnaces by gas. H. XHYGNESSE. *Glass*, **4** [3], 111 (1927).—For abstract see *Ceram. Abs.*, **6** [7], 278 (1927). A.J.M.

Testing of flue-gas analysis. A. B. HELBIG. *Centralblatt der Hütten und Walzwerke*, **30** [40], 421–23 (1926).—The new conception of the "nitrogen number" of combustion gives a simple way for the quick determination of the carbon and hydrogen loss during firing. The calculations involved in making these determinations from Orsat analyses are explained. E.J.V.

Valuation of producer gases. D. J. HUDLER. *Centralblatt der Hütten und Walzwerke*, **31** [1 and 2], 14–16 (1927).—A discussion of producer gas manufacture and points to be carefully watched in order to obtain gas of highest calorific value. Examples of gases produced from different cokes and hard coals at different plants are cited, comparing their analyses and fuel values. E.J.V.

Combustion of technical gases. A. B. HELBIG. *Centralblatt der Hütten und Walzwerke*, **31** [8], 91–95 (1927).—The combustion calculations for industrial gases are intrinsically simplified and much more clearly figured through the replacement of the measure of volume as a basis of calculation by the quantity of heat, 100 small calories = 1 large calory, and the lowering of the temperature by supplementary air is proved to be a waste. E.J.V.

Specific heat of solid fuels. K. D'HUART. *Centralblatt der Hütten und Walzwerke*, **31** [10], 120–25 (1927).—The literature is reviewed and values for the specific heats of

pure carbons (graphite and charcoal), cokes, ashes, moisture, and volatile matter are given. The methods of calculating specific heats of solid fuels from their rational analyses are explained. E.J.V.

Determination of calorific values of solid fuels. KARL D'HUART AND MARTIN W. NEUFELD. *Centralblatt der Hütten und Walzwerke*, **31** [22], 296–301; [24], 327–30; [26], 358–60; [28], 387–88; [32], 441–46; [34], 476–79; [36], 510–15; [46], 673–76; [48], 696–700; [50], 731–33; [52], 753–57 (1927).—The standards for performance tests on steam boilers and steam engines in 1899 are discussed and plans for a supplement in 1926 are explained. The formula for the determination of calorific value of solid fuels, known as the Dulong formula, is explained and its origin traced. The elementary analyses of organic materials by Saussure, as well as by Gay-Lussac and Thenard are spoken of, as are the calorimetric researches of Crawford, Wilcke, Lavoisier and De La Place, and Rumford. Dulong's investigations on heats of combustion are cited. Methods of verifying the so-called Dulong's formula for calorific value and the advancement of other calorific value formulas are taken up in detail. Determination of calorific value according to Berthier and the so-called Welter's law are discussed and criticized. Methods of determining calorific values from the rational analysis are explained. Calorimetry has steadily been improved upon as a tool for determining heat values. E.J.V.

Ceramic firing in electrically-heated kilns. ANON. *Clay-Worker*, **89** [5], 393–94 (1928).—A new electric kiln of the tunnel type with recuperative chambers for preheating and cooling the charge has been developed by the Electric Furnace Co., of Salem, Ohio. Two rows of cars moving in opposite directions can be accommodated. The most notable advantages of this kiln are the big saving in firing time and the uniformity of results in the finished ware. The cost of operation is very low and even shows an appreciable saving over the cost of even the cheapest of fuels used. It is applicable to ceramic processes requiring temperatures up to 2250°F. E.J.V.

Operation of coke and gas works through a distillation test of coal. L. LITINSKY. *Die Messtechnik*, **2** [10], 186–90 (1926).—The test apparatus is described. An example of the valuation of results obtained in a test is given. E.J.V.

Gas analysis. HANS KRESSE. *Die Messtechnik*, **2** [15], 346–47 (1926).—The determination of carbon monoxide, as well as methane and hydrogen from a common sample is described. E.J.V.

Determination of calorific values of fuels. J. ESTERMANN. *Die Messtechnik*, **3** [6], 167–72 (1927).—The legal definition of a heat unit is given. The conceptions of heat of combustion, upper and lower calorific values are explained. The experimental determination of calorific values of fuels with the aid of the Berthelot bomb and the Junkers calorimeter is described. Calculation of calorific value from the chemical analysis is explained. E.J.V.

BOOKS

Applied Heat. J. OELSCHLÄGER AND H. MOSS. x+334 pp. with 270 figures. Blackie & Son, Ltd., London, 1928. Price 30*s*.—A joint German-English production on heat engineering. H.H.S.

Waste-Heat Engineering. Vol. I. HANS BLACKE. Published by R. Oldenbourg, Münick u. Ber., 1928. 290 pp., illustrated. Price 15RM. Reviewed in *Min. and Met.*, **9** [256], 203 (1928).—The first volume of a 3-volume work upon waste-heat engineering. It discusses first the sources of waste heat, including exhaust steam, flue gases, condensed steam, cooling water, and excess electrical energy. It then takes up the principal elements of plants for utilizing waste heat and considers in detail the construction, use, and efficiency of each. F.P.H.

PATENTS

Liquid fuel burner. LEWIS A. COCKLIN. U. S. 16,954, May 1, 1928 (Re-issue). In a burner, an upright annular chamber open at its top and having its inner wall forming a flue for the upward passage of air, a granular filler in the chamber, means for conducting liquid fuel to the chamber, means located below the upper edge of the inner wall for catching overflow from the same and a spreader cap above the flue and having a concave lower face and projecting outwardly slightly beyond the inner wall of the receptacle and forming a constricted passage for the air at a point between the inner and outer walls and adjacent the inner wall, the relative arrangement of the cap and the receptacle directing the air impingingly toward the filler.

Furnace. IRA W. FOLTZ. U. S. 1,666,200, April 17, 1928. A furnace comprising surrounding walls forming a fire box and combustion chamber, a grate in the fire box located above the level of the floor of the combustion chamber, a bridge wall located at the rear of the grate, a pier on the bridge wall near the middle thereof and extending from the top thereof substantially to the roof of the furnace, the front surface of the pier being at right angles with the side walls of the furnace and the lateral sides thereof being parallel with the side walls of the furnace, and wing piers joined to the side walls of the furnace at a point rearwardly and equidistant from the bridge wall, the wing piers extending from the floor of the combustion chamber substantially to the roof thereof, the front surfaces of the wing piers being at right angles with the side walls of the furnace, a pier located rearwardly from the wing piers near the middle of the combustion chamber and extending from the floor thereof substantially to the roof thereof, the front surface of the pier being at right angles with the side walls of the furnace.

Oil burner. EDWARD SKILLMAN. U. S. 1,666,268, April 17, 1928. A fuel oil burner comprising a body having a steam passage therein, the outlet of the passage being formed by two opposed parallel plane surfaces one of which is constituted by a screw adjustably mounted in the body, a fuel nozzle extending back and upwardly from the plane surfaces at an acute angle with respect thereto whereby fuel oil issuing from the fuel nozzle is received at an acute angle on the sheet of steam issuing from between the plane surfaces, the bore of the fuel nozzle being circular in cross-section and the end thereof being formed on a slant which is substantially perpendicular to the plane surfaces of the steam outlet.

Boiler. GEORGE L. WELLER. U. S. 1,666,276, April 17, 1928. A waste-heat boiler comprising a heating chamber, a plurality of banks of tubes inclined from front to back of the chamber, tube headers connecting the tubes of the banks at each end, an expansion and steam drum above the banks of tubes, means connecting the headers with the expansion and steam drum, a baffle wall extending vertically in the heating chamber intermediate the front and back walls of the chamber so as to divide the chamber into primary and secondary heating zones, an inlet for the waste-heat gases communicating with the primary heating zone, an outlet passageway for the waste-heat gases communicating with the secondary heating zone, a bank of tubes extending longitudinally of and inclined from back to front of the outlet passageway, tube headers connecting the rear ends of the tubes of the last bank and communicating with the tube headers connecting the rear ends of the tubes of the 1st-named banks of tubes, other tube headers connecting the forward ends of the tubes of the last-named bank of tubes, a combined feedwater and blow-off drum communicating with all of the tube headers, connecting the forward ends of the tubes of the last-named bank of tubes, and a stack flue communicating with the outlet passageway below the forward end of the last bank of tubes.

Construction of furnace walls and arches. WILLIAM A. GILCHRIST. U. S. 1,666,284, April 17, 1928. A furnace wall or roof comprising in combination, two layers of blocks of different character with respect to their heat insulating and refractory properties,

the blocks of one layer being of heat insulating material and the blocks of the other layer being of refractory material and having portions interlockingly engaged with portions of the heat insulating blocks and being supported thereon and covering the same upon the inside of the furnace.

Furnace. CHARLES J. HUBER. U. S. 1,666,418, April 17, 1928. In a furnace having a feed opening, a grate, a coking shelf extending backward into the furnace at the lower side of the feed opening, above the grate and above the normal position of the fuel on the grate, a top wall exposed to radiation from the fire and extending backward above the shelf, the coking shelf and top wall being of heavy resistive material and serving as heat reservoirs to store heat and transmit it to the fuel, the furnace structure comprising a free and unobstructed passage for admitting outside air beneath and forward of the shelf, and a passage admitting air to the feed opening at the top surface of the fuel on the shelf.

Oil-burning attachment for furnace fronts. GEORGE NORMAN SCOTT. U. S. 1,666,511, April 17, 1928. A furnace attachment of the class described comprising a furnace ring formed of segmental sections of refractory material, a plate member having an aperture co-axial with that of the ring, and means carried by the plate member for engaging the sections peripherally in order to hold the latter in place as a unit with respect to the plate member.

Gas producer. CHARLES W. LUMMIS. U. S. 1,666,604, April 17, 1928. In a gas producer, a shell and a water-seal pan connected together and for rotation in unison, means for supporting the shell from the pan, an independently revoluble ash plow supported on the bottom of the pan, a rotatable member to which the plow is secured, making a seal with water in the pan, and means for imparting a rotation to the member independently of and at a speed different from the rotation imparted to pan and shell.

Furnace. OWEN H. GRAY AND CHARLES E. MURDOCK. U. S. 1,667,001, April 24, 1928. In a furnace, the combination of a mechanical fuel feed, means for periodically operating the fuel feed independently of temperature requirements, and means for varying the duration of the periodic fuel feeding operations produced by the first means and the intervals between the operations with the temperature requirements of the furnace.

Fuel oil burner. CARL A. KILGUS, CHESTER A. BURTON, AND GEORGE O. BERGMOSER. U. S. 1,667,122, April 24, 1928. A fuel oil burner having a target plate, a water boiler having an annular portion spaced below the plate to permit air to flow therethrough and upwardly around the periphery of the plate and provided with an upright portion extending upwardly above the plate at one side thereof and in proximity thereto, a mixing chamber spaced above the plate and in proximity to the upper end of the upright portion of the boiler, the mixing chamber provided with an outlet to discharge a fuel mixture toward the target plate, a steam passageway leading from the boiler to the mixing chamber and a fuel passageway leading into the mixing chamber.

Manufacture of fuel briquets. ERNEST WINDSOR BOWEN. U. S. 1,667,304, April 24, 1928. A method of the kind set forth for the manufacture of fuel briquets characterized by the separation of the fine dust or flour from the granular portion of the fuel while dry, and the re-introduction of a definite proportion of dust or flour into the granular material after the latter has been mixed with the binder.

Fuel briquet. JACOB SHOTWELL ROBESON. U. S. 1,667,358, April 24, 1928. A fuel briquet of tubular form, including fine coal, oil, and lignone, the surface portions being harder than the inner portions, and containing a lower percentage of volatile matter.

Automatic fuel oil superheater. GEORGE BAKER. U. S. 1,667,713, May 1, 1928. In combination, a furnace for heating water and generating steam, a pipe for feeding fuel oil to the furnace, means for guiding heated water and the steam independently

around a section of the pipe and individual control means for the water and the steam, an expansion chamber in the steam-conducting means and adapted to be evacuated thereby for producing a vacuum when the steam condenses and for causing the water to pulsate back and forth.

Gas burner control. EPPA H. RYON. U. S. 1,668,251, May 1, 1928. In combination, a fuel line delivering fuel to a burner, a pilot light associated with the burner, an electrode mounted adjacent the pilot light, an electromagnetically operated valve for controlling the delivery of fuel to the burner, a 2nd electro-magnetically operated valve for controlling the delivery of fuel from the fuel line to the pilot light, and a circuit closer operable by the 2nd valve and electrically connected to the electrode, the 2nd valve having its operating mechanism electrically connected to the operating mechanism of the 1st valve whereby opening of the 1st valve will simultaneously actuate the 2nd valve and the circuit closer, thereby increasing the delivery of fuel to the pilot light and causing an electric spark to be produced between the electrode and the pilot light.

Machine for comminuting coal and creating a draft to feed it. PAUL L. CROWE. U. S. 1,668,356, May 1, 1928. In a device of the character described, the combination of a hollow body including a hopper, and a rotor in the hollow body and including a part which is rotatable within the hopper and is provided with means to coöperate with the hopper for pulverizing coal or the like, means being provided for creating a draft of air through the hopper and for discharging a mixture of the air and pulverized coal or the like.

Manufacture of fuel briquets. ALICE MARION HART. U. S. 1,668,643, May 8, 1928. A fuel briquet composed of finely-divided carbonized vegetable matter in the form of grasses, weeds, leaves, tropical waste, and sea weeds, together with a binding agent of sodium silicate.

Oil burner. CHARLES L. RAYFIELD. U. S. 1,668,697, May 8, 1928. In combination in an oil burner a housing having openings in its wall, oil pumping mechanism in the housing, an air compressor in the housing, means for sucking air into it through the openings and for circulating it around the compressor to cause it to be preheated by the heat given off by the compressor, a nozzle connected to the housing into which oil from the mechanism is discharged and into which the preheated air is discharged, and an oil line connected to the pumping mechanism and arranged so as to receive heat from the heated air delivered to the nozzle.

Drier. OTTO NORDSTRÖM. U. S. 1,669,012, May 8, 1928. In a drying plant, in combination, members forming a vertically extending annular compartment for the reception of material to be dried and surrounding a central chamber, a casing wall surrounding the members forming a space surrounding the compartment, a conduit for supplying gas to the central chamber, a stack connected to the upper portion of the casing, a recirculating conduit connecting the lower portion of the casing with the conduit for supplying gas to the central chamber and a horizontal baffle shelf between the annular compartment and the casing arranged above a portion of the recirculating conduit.

Induction furnace. JAMES M. WEED. U. S. 1,669,109, May 8, 1928. An induction furnace comprising a primary winding, a refractory receptacle providing a looped cavity adapted to contain a liquid charge constituting a secondary, the primary and secondary being structurally so related that the spacing from the primary of sections of the secondary in planes passing through the axis of the primary increases progressively from one end of the sections to the other, and a passage external to the secondary through which charge may circulate between portion of the secondary spaced different distances from the primary.

Process for making oil gas. CYRUS A. PHELPS. U. S. 1,669,172, May 8, 1928. A process for producing oil gas from oil in an apparatus including a checkerbrick fixing chamber, including completely burning a portion of the oil with air and with the heat from the combustion heating up the heat retaining checker brick to a temperature above the reaction temperature of the products of combustion with volatilized and cracked products of the oil, volatilizing and cracking a remaining part of the oil with heat from the combustion, meanwhile maintaining the oil and its cracked and volatilized products completely separate from the combustion and the products of combustion, then mixing the volatilized and cracked products with products of combustion from the burning of the oil, and then carrying the products into contact with the heated checker brick and thereby fixing the volatilized and cracked products and the products of combustion to produce a uniform combustible gas.

Process for distilling and liquefying coal. FRIEDRICH BERGIUS. U. S. 1,669,439, May 15, 1928. Process which comprises subjecting coal to distillation treatment whereby there are produced ammonia, coke, tar, a gaseous fraction relatively poor in hydrogen but of high heating value and a gaseous fraction relatively rich in hydrogen, admixing the tar with coal and subjecting the mixture to liquefaction and hydrogenation treatment with the gaseous fraction relatively rich in hydrogen at elevated temperature and under great pressure whereby there are produced ammonia, oil, and a gas of high heating value, combining the gas of high heating value with the gaseous fraction relatively poor in hydrogen, and separately recovering the oil.

Flue-draft door. THOMAS OLINGER. U. S. 1,669,533, May 15, 1928. A device of the class described comprising a supporting fixture having a flange shaped to fit against a cylindrical smoke pipe and a cylindrical member extending from the flange having an open outer end, the cylindrical member having a plurality of openings through the sides thereof, a bracket, means for attaching the bracket to the cylindrical member at a plurality of different positions defined by the openings therethrough, and a draft door pivotally mounted on the bracket.

Heating kiln. BOYD M. JOHNSON. U. S. 1,669,563, May 15, 1928. In a furnace, a heating compartment, a combustion chamber for the compartment, and a baffle intermediate the chamber and compartment and having its lower portions of higher thermal conductivity than its upper portion.

Powdered-coal feeder. WILLIAM M. THOMAS. U. S. 1,669,635, May 15, 1928. An apparatus for feeding pulverized fuel, comprising a hopper having aligned openings in its opposite walls, a tube in the hopper including a perforated segment and an imperforate segment, a conveyer rotatably mounted in the tube and including a brush for sweeping powdered fuel from the perforated portion of the tube, means for drawing air through the openings and the tube, and means in the hopper for regulating the fuel fed to the perforated portion of the tube.

Furnace-slagging apparatus. HARRY E. DUNKELBERGER AND NICK WITTIERS. U. S. 1,669,696, May 15, 1928. In a furnace of the character described, a slag-container located over the furnace arch, gravity feed passages leading from the container to the interior of the furnace adjacent to the top of a wall of the latter, and a horizontally disposed rotary valve whereby the passages may be opened and closed.

Stoker ram drive. DALLAS F. GRAHAME. U. S. 1,669,705, May 15, 1928. In a screw drive for an underfeed stoker ram, a plunger, a screw, means to rotate the screw in either direction, a nut coacting with the screw and plunger to carry the plunger in either direction through a definite range of movement when restrained against idle rotation with the screw, and restraining means controlling the nut.

Automatic stack or flue control. PIERRE E. HAYNES. U. S. 1,669,707, May 15, 1928. A thermostatic draft control for combustion processes comprising a valve, a

shaft supporting the valve, a bimetallic strip rigidly attached at one end to the valve, a casing enclosing the previously described mechanism and slotted to receive the free end of the bimetallic strip.

Furnace. JOHN MCCARTEN AND ALFRED GEORGE MATTSSON. U. S. 1,669,720, May 15, 1928. A boiler comprising a semicylindrical fluid container having semicylindrical walls in spaced relation; end walls mounted thereon and integral therewith; spaced longitudinally extending L-shaped supporting standards adapted for engaging the edges of the container for supporting the same, the inner diameter of the container being equal to the space separating the standards; supporting brackets projecting inwardly from the inner surface of each supporting standard and above the bases of the standards; grates mounted on the brackets and position below the point of engagement of the container with the supports; outwardly projecting brackets on the supporting standards for reinforcing the same; a semicylindrical outer shell supported along its edges by the supporting standards and in spaced relation to the container; and a front and rear wall coöperating with the outer shell for enclosing the container.

Tunnel kiln. JOHN B. OWENS. U. S. 1,669,777, May 15, 1928. A tunnel kiln having a multiple firing or burning zone comprising a plurality of combustion chambers arranged in succession, each provided with an angularly arranged deflecting or baffling wall, the chambers being in communication.

Furnace. EDMUND GEORGE WEEKS. U. S. 1,669,796, May 15, 1928. In a furnace, a mechanical stoker device including a grate, a closure for the furnace front, means coöperating with the closure to form a chamber separated from the combustion surface of the grate but including the front end of the grate so as to afford access to the fuel-receiving surface of the grate, a mechanism to supply cool inert gases to the interior of the chamber, the coöperating means comprising a partition forming a baffle for the inert gases and preventing the inert gases from passing directly to the combustion space, the partition extending beneath the combustion section of the grate to the back end thereof.

Annealing and heat-treating furnace. ARTHUR T. KATHNER. U. S. 1,669,902, May 15, 1928. A continuous annealing furnace comprising a heating chamber and a cooling chamber arranged in aligned relation and separated by a fire wall which has a passage in its lower portion providing communication between the chambers, continuous means for conveying material through the chambers, a damper controlled stack leading from the forward end of the heating chamber, means for deflecting products of combustion away from the passage and toward the stack, a shiftable fire door whereby the admission of heat through the passage is controlled, the cooling chamber embodying an archlike top having sections which are removable for facilitating heat dissipation.

Fuel burning system. LEPORT R. VAN SANT. U. S. 1,669,956, May 15, 1928. The combination in a liquid fuel burning system including a fuel containing reservoir, a burner, a pump and fuel lines between the reservoir and burner, of a controlling means forming a connection between the fuel lines and the reservoir and having communicatoin with an air supply, a fuel supply pipe suspended within the reservoir and communicating with the controlling means, a return fuel pipe also suspended within the reservoir and communicating with the controlling means, the controlling means arranged to drain fuel therefrom on the cessation of the pump and to replace the drained fuel with air from the air supply, and adapted to receive fuel on the operation of the pump to displace the air and create a siphonic action in the system, means for applying a heating medium to the fuel lines to raise the temperature of the liquid fuel on its passage from the reservoir to the pump and insulating means forming a casing for the supply and return pipes located within the reservoir.

Process for making producer gas. HENRY L. DOHERTY. U. S. 1,670,102, May 15, 1928. A process of making producer gas, comprising passing fuel in a column downwardly through a shaft, introducing air under induced draft into the major portion of the upright sides of the column to promote gas-making reactions therein, controlling the air supply to maintain the highest gas-making temperatures in the upper portion of the column, removing producer gas formed adjacent the top of the shaft, introducing flue gases for controlling combustion into the lower part of the fuel column, and controlling the movement of flue gases upwardly through the fuel column to cause a lowering of temperature in the fuel as it advances below the mid-portion of the column.

Method of burning pulverulent fuels. EDWARD B. WORTHINGTON. U. S. 1,670,276, May 15, 1928. In a furnace of the class described, the combination with its combustion chamber, of means for directing a fuel cloud downwardly therein, an adjacent inclined slagging surface, and controllable means for deflecting the deflagrating fuel cloud to melt any accumulated slag from the inclined surface, substantially as set forth.

Apparatus for feeding powdered fuel to continuous brick kilns. J. WALMSLEY. Brit. 267,660, Jan. 22, 1926. (*C. A.*)

Drying furnaces. G. HERRMANN. Brit. 285,546, April 12, 1928. Solid fuel is burnt to heat up quickly a mass of checker brickwork interposed between a grate and a drying-chamber, and the heat absorbed by the brickwork is then utilized to maintain for a longer period a stream of hot air in the drying chamber. In the construction shown the brickwork is arranged above the grate and above the open ends of side flues leading from the fireplace. The drying chamber has no communication with the atmosphere except through the chimney and the fireplace. The bricks forming the checkerwork may be tapered upwards to minimize deposition of dust.

Furnaces. W. H. OWEN. Brit. 285,550, April 12, 1928. In an air heater of the plate type the elements in the form of bundles of plates are insertable or removable one after the other through doors parallel with the plates at the sides of the heater, *i.e.*, at the ends of the rows of elements. Plates are inclosed in a sheet-metal casing having openings for the inlet and outlet of air, and are arranged in a casing having openings at top and bottom for waste gases, which pass upwardly in alternate spaces between the plates. Steam pipes are arranged to blow a jet of steam between the plates for removing soot. Air supplied by a duct between the rows of elements passes through the openings, down the air spaces between the plates, and through the openings to an outlet duct separated from the inlet duct by a partition. In modifications the rows of elements are placed back-to-back and the air ducts arranged on their outer sides, and two or more rows of elements may be superposed in tiers. To facilitate insertion and removal of the bundles of plates a runway may be arranged at the top of the casing supporting on wheels a trolly having a hook to engage an eye on a cross-bar at the top of each bundle, or the bundles may have rollers on which they can be pushed into position.

Furnaces. W. H. OWEN. Brit. 285,783, April 18, 1928. An air heater of the plate type has removable bundles of heating elements arranged on each side of air inlet and outlet ducts, the air spaces between the plates communicating with the ducts through openings. A horizontal partition separates the air inlet duct from the outlet duct so that the air passes downwardly while hot waste gases pass upwardly in alternate spaces between the plates, steam pipes being provided to act as soot blowers. Doors for removal of the elements are placed at the ends of the rows. Two or more rows of elements may be superposed in tiers on each side of the air ducts.

Pottery kilns. T. SIMPSON. Brit. 285,935, April 18, 1928. In a kiln for firing pottery, tile, etc., having fire mouths beneath the floor of the kiln chamber, the heating gases from each mouth divide and pass upward through back and front wall flues, the streams uniting at the top and passing thence downward through a back wall flue,

beneath the floor, and finally upward through a front wall flue. The space beneath the floor of the kiln chamber at the back of each fire mouth is divided by a mid-feather. To facilitate cooling down, the upper part of the kiln chamber is fitted with a damper-controlled outlet.

Drying fuel gases. C. Cooper and W. C. Holmes and Co., Ltd. Brit. 285,936, April 18, 1928. Fuel gases passing through a main are by-passed through brush-washers in which they are treated with hygroscopic liquid, the liquid being cooled and regenerated by circulation through independent circuits connected to the washers. The washers are formed with pairs of communicating compartments between each of which and coolers the liquid is circulated by pumps. For regeneration, the weak liquid from the washer is directed through a pipe to a tank communicating with a pump which circulates the liquid in part through a pipe and over evaporators back to the tank and in part into a tank from which the liquid flows through a pipe to the washer, the liquid space of which communicates through a pipe with the liquid space of the washer.

Furnaces. A. W. Bennis. Brit. 286,074, April 25, 1928. Fuel is heated and dried by furnace gases during its passage from a hopper to compartments of increasing capacity containing one or more reciprocating rams operated by a lever on an oscillating shaft. The hopper throat is controlled by a slide and the gases from the furnace are drawn through the fuel, as it passes to the compartments into a channel leading to the furnace flue or elsewhere. Such channel may be controlled by a damper or fan or other inducing means. Where a damper is provided it may be controlled by thermostatic means dependent on the temperature of the gases passing through the channel.

Furnaces. E. Dittmar. Brit. 286,084, April 25, 1928. In a boiler furnace fired by pulverulent fuel the walls are mounted upon elastically-supported girders and the roof arch is carried by resiliently-supported rods in order that they may freely expand and contract. The girders are supported from fixed girders by tie rods having at their free ends nuts bearing on pressure springs which press the girders against the refractory brick of the walls. The rods supporting the roof have springs fixed to girders carried by vertical girders. The lower end of the chamber rests by means of rails upon roller bearings. The burner nozzle is directed so that the flame is parallel to the arched wall.

Burner apparatus. E. C. R. Marks. Brit. 286,093, April 25, 1928. In a liquid fuel burning device the fuel and air are supplied to the burners from a separator chamber or reservoir in which the air pressure and fuel level are maintained constant. The reservoir supports an electric motor the shaft of which drives at one end an air compressor and a rotary fuel pump, and at the other end a fan arranged in a casing. The air from the compressor is supplied to the reservoir through a pipe and then passes through pipes to the burners. A relief valve allowing the escape of excess air to the intake pipe of the air compressor ensures the maintenance of a constant pressure in the reservoir. The compressor comprises a rotor eccentrically mounted in a chamber and carrying slidable vane members. The compressor chamber is lubricated by oil drawn from the reservoir through a pipe and sight-feed member. This oil will be delivered with the compressed air to the reservoir where separation will take place. The pump draws fuel from a main tank and forces it through pipes to the reservoir, the supply being controlled by a float-operated valve in the reservoir. Excess fuel is returned through an adjustable pressure valve to the main container. The fuel and air pipes leading from the reservoir are provided at each burner with tappings, leading through a single pipe to the discharge jet. Additional air is supplied through a housing communicating with a pipe leading from the fan casing. This additional air is whirled at its discharge point by a spiral. In a modification the pipe delivers the fuel into the air intake pipe of the compressor so that the air and fuel are delivered together in a frothy mixture to the reservoir.

Furnaces. E. COCKIN. Brit. 286,098, April 25, 1928. In a boiler furnace employing one or more traveling fire-grates the arch or arches above the grate are formed in sections of opposing camber supported on the side walls and mid wall. The thrust in the wall is taken by a strut which also supports the back wall of the furnace.

Furnaces. F. L. BOLT. Brit. 286,402, April 25, 1928. In a furnace designed for burning pulverized coal of the kind having provision for the substitution for the coal burner of a substantially vertical oil burner, the same supply of air as serves for injecting coal being used for injecting oil, the low pressure oil burner is adapted to be fitted into the housing of a known form of powdered coal burner and is provided with an adjustable flame tube the position of which may be varied by draw handles extending beyond the burner housing. Oil is supplied to the burner through a valve and the injecting or atomizing air through a pipe.

Distilling powdered fuel. W. E. EVANS. Brit. 286,404, April 25, 1928. In the low temperature distillation of powdered or granular fuel which passes through the distilling chamber in suspension in a gas, hot producer or water gas is used immediately after leaving the gas producer and is fed into the distilling chamber together with the powdered fuel through a common nozzle. A number of distilling chambers may be used whereby distillation is effected in stages. When two retorts are used the powdered fuel from a hopper is projected by hot combustible gas through a nozzle into a shaft, the residue falling through the annular space surrounding the shaft and being collected with the distillates in a dust separator from which the distillates pass through a condenser, the gases and tar leaving by separate outlets. The incompletely coked residue is transferred to a 2nd retort where it is treated in a similar manner by hot gases from a producer entering by a nozzle. The distillation gases and unconsumed coke pass to a dust separator, the powdered coke from which is fed by a pipe to the producer, the gas passing by a pipe to a pump and heater before entering the retort. In an alternative form of retort, the heating gas and fuel are blown by nozzles through inclined tubes opening into a dust separator. A heating gas may be conducted through the space surrounding the tubes to heat the latter on the outside. A nozzle for injecting powdered fuel comprises a hot gas conduit delivering into a restricted passage into which openings lead, through which the fuel is supplied from a pipe and annular space.

Geology

Flotation of low-grade phosphate ores. H. M. LAWRENCE AND F. D. DEVANEY. Bur. Mines, *Report of Invest.*, Serial No. 2860 (1928).—An investigation of flotation for Florida phosphates is now under way. The work reported in this serial has been largely confined to screen-undersize products rejected by the washers. In the washing plants coarse phosphate only is saved. The phosphate grains in the material discharged to waste are generally finer in size than 14- to 20-mesh. About 60% of the matrix mined is at present recovered the remainder being waste. This material is granular and practically free from clay. Also these undersize products frequently have a phosphate content but little below that of commercial rock and only require the removal of small amounts of quartz gangue to render them marketable. Preliminary work has indicated that oleic acid and sodium oleate would give some selective action between the phosphate and quartz reagent combinations have been mainly limited to those containing these two reagents. Results of two typical tests are given. R.A.H.

Titanium in bauxite ores and sludges. WILL H. COGHILL. Bur. Mines, *Serial*, No. 2867, 4 pp. (1928).—Titanium is a well-known component of bauxite ores, sometimes occurring in sufficient quantity to make its recovery worth considering. This question has been raised by some of the companies lixiviating bauxite ores. At the East St. Louis plant of the Aluminum Ore Co., the waste sludge discharge daily contains

over 75,000 lbs. of TiO_2. The sludge is all through 20-mesh, and a large proportion is slime. A sample of the waste was deslimed so that a gravity concentration test of the "sand" could be made. The Aluminum Ore Co. coöperated in the work and made the chemical determinations. The results of the gravity concentration did not invite commercial tryouts because by the float and sink tests the best cut was of low tenor. Results of the tests are given. R.A.H.

Fullers' earth in Pulaski County, Ill. J. E. LAMAR. *Rock Prod.*, **31** [9], 47 (1928).—For abstract see *Ceram. Abs.*, **7** [6], 400 (1928). F.P.H.

Potash in New Mexico. ANON. *Chem. and Ind.*, **47**, 394 (1928).—The U. S. Geological Survey reports the discovery in Eddy County, New Mexico, of 9 beds of potash of commercial interest within 1500 ft. of the surface. One bed 8 ft. 10 in. thick, contained 11.08% K_2O, while other beds ranged in thickness down to 2 ft. 3 in., and in potash content from 8.5–13.68%. The bores were drilled by the U. S. government. H.H.S.

Fire clay and silica of Mattagami area. W. S. DYER AND R. J. MONTGOMERY. *Clay Prod. News*, **1** [1], 6 (1928).—A report based on observations made during the summer of 1927 while investigating the geology of several rivers in the Moose River basin. Physical tests made by M. on 33 clays from the Mattagami and Missinabi rivers proved that 21 of them are first-class refractory clays. The deposits are extensive, and transportation costs should not be prohibitive when a spur line railway has been built. The white quartz sands are of a fair grade, but the cost of transportation is more serious in view of the low market price of sand. H.H.S.

Precipitation of iron and silica under natural conditions. E. S. MOORE. Nat. Res. Council Canada, *Ann. Report*, **10**, 96–97 (1928).—The amount of iron carried in solution in a water is largely dependent upon the amount of organic matter in the water. If unsterilized "muck" from stream bottoms is added to a solution of an iron salt, the iron is quickly precipitated as oxide; but if the same material is sterilized, the iron is not precipitated, thus showing the influence of bacteria on iron. The presence or absence of light, oxygen, or CO_2, does not affect the rate of precipitation. Iron from inoculated solutions is very different in character from iron precipitated by hydrolysis, the former being granular like limonite, the latter flocculent like the $Fe(OH)_3$ obtained with ammonia. With regard to the deposition of silica, it is pointed out that previous investigators have worked at concentrations far in excess of those found in natural waters. Thus $MgSO_4$ precipitates Mg silicate in concentrated solution, but with 25 parts per million, or less, of SiO_2, complete hydrolysis takes place. The time factor appears to be the most important in silica precipitation. H.H.S.

Fifteenth International Geological Congress, 1929. ANON. *Science*, **67**, 191 (1928).—The 1929 Congress will be held in South Africa; the date of the inaugural meeting in Pretoria is to be during the fortnight following July 29. Provisional subjects for discussion are magmatic differentiation, pre-Pleistocene glacial periods, and the stratigraphy, paleontology, and world distribution of the Karroo system. H.H.S.

Photographic plate for geologists. E. BLECKWELDER. *Science*, **67**, 275 (1928).—Blue haze, presumably caused in arid regions by the fine dust which desert winds keep more or less continuously suspended in the atmosphere, obscures photographs of features such as distant mountains. Krypto-cyanine, a dye which confers sensitivity to a narrow range of color near the red end of the spectrum, was used by W. H. Wright and the Lick Observatory staff for testing plates. A scene is thus taken entirely by deep-red light, the blue rays scattered by dust particles are eliminated, and a sharp clear picture is obtained at great distance. B. was able to recognize details of the Yosemite gorge at 115 miles. The drawbacks to the process are that the sky appears black, relieved by white clouds, and dry grass and shrubbery take on whiteness as if covered with snow. H.H.S.

Pyritic clays in the Buntsandstein of east Thuringia. HERMANN HARRASSOWITZ. *Centr. Mineral. Geol.*, **B**, 345–57 (1927).—These are thin layers and lenses of bluish green clay with finely disseminated pyrite, local coaly seams, and mud-cracked surfaces. They are believed to have formed as organic sulphide muds in temporary fresh-water lakes in an arid region. Slight metallic enrichment under typical arid conditions followed. An analysis of the clay is included. (*C. A.*)

Occurrence and origin of kaolin in the lower Austrian forests. L. KÖLBL. *Mineral. Petrog. Mitt.*, **37**, 173–200 (1927).—Deposits of kaolin have long been worked in the crystalline schists. They occur along crevices, and it is concluded that they have been formed *in situ* by weathering beneath a covering of peat (bands of lignite occur in the associated beds of Tertiary age). Analyses are given of the fresh rock (granulite) and of the portions soluble in concentrated HCl and in H_2SO_4 of the weathered rock, of the completely weathered sandy débris, and of the clay nodules. In the fresh rock, SiO_2: Al_2O_3: bases = 8.15:1:1.12, and in the HCl extracts of the weathered products, SiO_2: Al_2O_3: bases approximates to 2:1:0, suggesting kaolin. (*C. A.*)

Quantitative mineralogical and chemical classification of igneous rocks. EDWIN T. HODGE. *Univ. of Oregon Publication (Geol. Series)*, **1**, 133–200 (1927).—The proposed classification differs from all others in that it permits rocks to be arranged both mineralogically and chemically. Rocks located by either method arrive at the same place in the classification. Further, this new plan differs from its predecessors in that it gives the mineral and chemical composition of any rock for which the location is known. The classification is quantitative and makes use of established nomenclature. A chart contains the plan and its data. Rocks are classified mineralogically in 4 great "classes"—A, B, C, and D—based upon the per cent of feldspars and feldspathoids. These "classes" are plotted in 4 sectors of a disk. These are subdivided into 19 "orders," numbered with Arabic numerals, based upon the ratio of orthoclase (and orthoclase equivalents) to the other feldspars. These "orders" are represented by intersecting, radiating sectors so constructed that each passes through every class. Finally, the "classes" and "orders" are divided into 7 "ranges," numbered with Roman numerals, based upon the law of saturation. These "ranges" are concentric, annular belts beginning with quartz rocks on the outside and ending with "metal" rocks on the inside. The "ranges" pass through every "class" and "order." The arrangement is such that the mineralogical composition gives the chemical composition. The quantities of SiO_2, Al_2O_3, Fe oxides, MgO, CaO, K_2O and Na_2O are expressed by contour lines which describe on the chart the percentages within the limits which can be expected from the natural variation of each oxide in the rock. (*C. A.*)

BOOK

Mineral Deposits. WALDEMAR LINDGREN. Third ed., 1049 pp., 313 illustrations. New York: McGraw-Hill Book Co., 1928. Price $7.00. H.H.S.

Chemistry and Physics

Oxygen bomb vs. Carius methods in determining sulphur in heavier petroleum oils. JOHN M. DEVINE AND F. W. LANE. Bur. Mines, Serial, No. 2866, 3 pp. (1928).—The oxygen bomb is used extensively for determining sulphur in petroleum although it has been suspected that the results obtained with the method are somewhat lower than the true value. The results given by the oxygen bomb and Carius methods are compared, the latter being generally accepted as the standard procedure for the determination of sulphur in organic compounds. The Carius determinations given here were made in connection with a special study of this method. R.A.H.

Water-absorbing capacity of ceramic products. JOSEF MATEJKA. *Sprechsaal*, **61** [3], 39–40 (1928).—The formula per cent of absorption $= \frac{\text{wet weight} - \text{dry weight}}{\text{dry weight}} \cdot 100$ does not give a sufficiently clear conception of the relative porosity of pottery because its value is not only dependent on the size of the open pores but also on the weight per unit volume of the material. It is therefore far more correct when estimating the relative porosity of materials to proceed from the volume relation and to refer the pore volume to the total specimen volume. The volumetric water absorbing capacity if therefore expressed by the following formula: per cent of volume of water absorbed $= \frac{\text{wet weight} - \text{dry weight}}{\text{volume of specimen}} \cdot 100$. A number of illustrations are given applying this principle. R.A.H.

Reactions in the solid mixture. E. KORDES. *Glastech. Ber.*, **6** [1], 44–50 (1928); *Rock Prod.*, **31** [8], 112 (1928); *Zement*, **17**, 94–98 (1928).—Up to a comparatively short time ago, there was a general opinion that two substances could only react with each other when in the liquid or gaseous phases. Investigations by different scientists during the last decade, among whom G. Tammann must be mentioned, led to the conviction that the crystallized condition of matter was in no way as slow to react as had previously been assumed. This was recognized first in metallography, as the metals belong to those substances that, on the basis of their relatively simple crystal structure, are most quickly in a position to take part in different kinds of chemical reactions in the solid condition. Also, reactions between crystals were never understood completely without the consideration of changes in the solid condition. Among the reactions in the solid condition there are a number of phenomena that fundamentally can be considered from the same viewpoint. These are "recrystallization," mixed crystal formation, and the formation of new chemical combinations in the solid state. All reactions in the solid state have a fundamental hypothesis for their being: the atoms or molecules in the crystal lattice of the individual components in the reaction must have a minimum degree of mobility, so that they can undergo a change of location in the solid state. Every substance has a temperature range typical for it, above which the reactions may take place in the solid state. It has been shown that this "critical" temperature, referred to the melting point of the substance in question, is lowest with the metallic elements, somewhat higher with the electrolytes, and highest with the molecular compounds. As a large part of the silicates with relatively complex structure approximate the typical molecular compounds, in general with them we can expect reactions in the solid state only at relatively high temperatures. At temperatures that are still below the melting point, the silicates must be very slow to react, as has been known in technology for a long time. If powder of a pure substance is heated, it will begin to cake together on exceeding a temperature that is typical for the substance in question. In this same temperature region new grain boundaries are formed in a pill pressed out of this substance. Simultaneously with this "recrystallization," as it is called, there generally takes place a consolidation of the pressed pill. Recrystallization therefore is of extraordinarily great importance for all consolidation phenomena as long as chemical influences or partial fusion do not come in. The phenomenon of recrystallization is a reaction in the solid state that takes place between two chemically similar crystal grains. On the other hand, if one heats a mixture of two different substances, disregarding the reduction in the melting point, they will either not influence each other at all until the fusion of the mixture starts, or, if they have approximately concordant crystal lattices, they give mixed crystals, or a chemical reaction takes place

between the two substances. The reactions between chemically different crystal grains of a mixture generally start only above the recrystallization temperature of the pure components. Only when the mobility of the atoms or molecules of the substances taking part in the reaction has become so great that they can diffuse into the other components, can the reaction take place with a velocity noticeable from the exterior. A great part of the processes resulting in the firing of ceramic products unquestionably has a connection with the reactivity of the substances in the solid condition. Even on heating the mixture determined for the production of glass, some chemical reactions take place before the first fusion starts. The reactions in which glasses take part are not truly included in this consideration, as the glasses must be regarded as undercooled liquids. What has been stated above holds for their reactivity with other crystalline substances; here, however, the temperature must be so high that there is a sufficiently great mobility of the atoms and molecules, of the participating substances, that take part in the reaction. E.J.V.

Use of the oscillation method in determining the structure of analcite. JOHN W. GRUNER. *Amer. Mineral.*, **13** [5], 174–93 (1928).—The oscillation method is used in the determination of the space group of analcite. It is shown how an oscillation diagram about a prominent crystallographic direction as an axis furnishes the primitive translation in this direction, *i.e.*, the distance between identical atoms. For a cubic crystal 3 oscillation spectrograms are necessary: (1) the axis parallel to the edge of the cube (001), (2) parallel to the face diagonal (110), and (3) parallel to the body diagonal (111). Each spectrogram is evaluated and plotted on the reciprocal lattice. The indices for each point are found graphically. These indices are used in the recalculations of the positions of the reflections in the spectrograms. If the agreement is close the indices are correct. Analcite has the cubic holohedral lattice and seems to belong to the space group O^9_h. The reflections, however, agree practically as well with the requirements of space group O^{10}_h. The correct choice between these two groups will have to be based on other considerations. The unit cube contains 16 molecules of $NaAlSi_2O_6H_2O$. Its edge is 13.64 ± 0.05Å long. F.P.H.

Use of the viscosimeter in the study of colloidal clay. A. DEMOLON AND G. BARBIER. *Keramos*, **7** [2], T15 (1928).—For abstract see *Ceram. Abs.*, **7** [6], 407 (1928). F.P.H.

Standard ceramic test methods in Czechoslovakia. O. KALLAUNER. *Tonind. Ztg.*, **51** [101], 1833–34 (1927).—Methods of determining the solubility of various ceramic bodies in concentrated sulphuric acid are described. F.P.H.

Representation of 4-component systems by means of parallelograms. SPINDEL. *Tonind. Ztg.*, **52** [2], 17–19 (1928).—A method of representing the composition in 4-component systems by means of parallelograms is described. F.P.H.

Advances in the chemistry of soils. W. T. H. WILLIAMSON. *Chem. and Ind.*, **47**, 391 (1928).—Recent work has thrown light on the mechanism of absorption of soluble substances by soils. The seat of the reaction appears to be mainly the clay and humus, which are present as colloidal gels. The works of Bradfield on soil clay and Odén on humus, ascribe to these substances true acidic properties. Mattson showed that practically identical proportions of bases are removed from the soil clay by electro-dialysis NH_4Cl, HCl, and methylene blue respectively, and further that the Ca removed by NH_4Cl from a soil backed with $CaCl_2$ is equivalent to the total cations removed from the same clay by electro-dialysis. Some of the cations are always H ions; complete saturation of bases would not occur until a p_H of 10–11 was reached, and Oakley has shown that the alumina-silicate complex breaks down into silicate and aluminate at a high p_H. Similarly at low p_H values, the alumino-silicate decomposes into its constituent oxides, with solution of Al and Fe. Mattson's measurements of electro-kinetic potential show that the greater number of cations is attached to the surface of the

particle, while a small number is dissociated forming an atmosphere of ions around the particle and giving rise to the charge. It is this conception of the soil absorbing complex as being acidoid, with surface active H and basic cations, that explains the known facts. H.H.S.

Colorimetric determination of antimony. S. G. CLARKE. (Soc. Publ. Analysts Meeting April 4.) *Chem. and Ind.*, **47**, 393 (1928).—Sb forms with pyridine and an iodide a golden-yellow compound, which may be used colorimetrically for the determination of Sb in either state of oxidation. Sn and As do not interfere, but Bi and several other heavy metals give colored precipitates with the reagents. H.H.S.

Determination of carbon dioxide in soils. A. RIAD. (Soc. Publ. Analysts Meeting April 4.) *Chem. and Ind.*, **47**, 393 (1928).—Hepburn's modification of the Van Slyke method of determining CO_2 in carbonates (by absorbing the evolved gas in excess of standard $Ba(OH)_2$ solution, and titrating back with oxalic acid) has been adapted to CO_2 in soils. The results quoted show that the method is suited to general soil analysis. H.H.S.

Research in analytical chemistry. ANON. *Chem. and Ind.*, **47**, 394 (1928).—The J. T. Baker Chemical Co., of Phillipsburg, N. J., has established a fellowship of $1000 a year in analytical chemistry to emphasize the need for fundamental research in inorganic analytical chemistry. H.H.S.

Chemical problems of Czechoslovakia. MILDRED V. COX. *Chem. Markets*, **22** 403–407 (1928).—A general view of the chemical industry of the country. Clay and pottery are not included, but glass is exported in very large quantities and is the medium for developing the sulphate of soda and potash industries. A protective tariff is needed. H.H.S.

Surface energy of solids. F. M. G. JOHNSON. Nat. Res. Council Canada, *Ann. Report*, **10**, 92–93 (1928).—The surface energy of solids is not susceptible of direct measurement as it is in the case of liquids. An indirect method was used for NaCl which should be applicable to any soluble salt. This was to determine, by a calorimeter, the difference between the heats of solution of coarsely crystalline and very finely divided material. The difference was 15.3 calories per molecule which is equivalent to a surface energy of solid NaCl of 386 ergs per sq. cm. H.H.S.

Swelling of bentonite and its control. C. W. DAVIS. *Ind. Eng. Chem.*, **19** [12], 1350–52 (1927).—For abstract see *Ceram. Abs.*, **7** [6], 404 (1928). R.J.P.

The isomorphous replacement of silicon by aluminum. WALTER WAHL. *Ann. acad. sci. Fennicae*, **29** [A], 12 pp.; *Z. Krist.*, **65**, No. 6 (1927).—An elaboration of the hypothesis that silicates and aluminosilicates are complex salts in which Si and Al both function with coördination numbers of 4 or 6. Hence in the isomorphous replacement of Si by Al there are no anomalous valency effects but the Si atoms of coördination No. 6 are replaced by Al atoms of coördination No. 6. Examples are drawn from the amphibole, pyroxene, and melilite group. (*C. A.*)

Dependence of surface tension on electric charge. O. RUFF, G. NIESE, AND F. THOMAS. *Ann. Physik*, **82** [iv], 618–26 (1927).—The relation between the surface tension on a spherical droplet of a conducting material and the density of the electric charge has been investigated. The equation $\sigma' = \sigma - \pi\rho\epsilon^2 - p/2\rho\pi$ (ϵ is the density of the charge in e.s.u., σ is the normal surface tension, σ' that of the charged droplet, ρ the radius) is deduced and confirmed experimentally for Hg. (*C. A.*)

Composition of alite. O. REBUFFAT. *Giorn. chim. ind. applicata*, **9**, 520 (1927).—The formula $8CaO \cdot SiO_2 \cdot Al_2O_3$ for alite proposed by Jänecke[1] is far from certain, several reasons being offered to show its improbability. The optical identification of alite is extremely difficult, and moreover in the electric arc where it was supposed to form, the temperature is high enough to fuse CaO and produce mixtures of CaO, SiO_2, and Al_2O_3

[1] See *Ceram. Abs.*, **7** [2], 105 (1928).

in various proportions without the formation of definite compounds. Still more important is the difference between the per cent composition attributed to alite and that of Portland cement. With the per cent of alite said to be in Portland cement and with the composition $8CaO \cdot SiO_2 \cdot Al_2O_3$ the remaining components would have to have a very improbable composition in order to make the integral composition of the cement agree with analyses of the latter. (*C. A.*)

Studies on glass. I. The transition between the glassy and liquid states in the case of some simple organic compounds. G. S. PARKES AND H. M. HUFFMAN. *Jour. Phys. Chem.*, **31,** 1842–55 (1927).—The compounds studied are Et alcohol, Pr alcohol, propylene glycol, and glycerol. In the glassy state these substances have almost the same values for heat capacity, thermal conductivity, and dielectric constant as in the crystalline condition, and not at all those of the liquid state. The total change of physical properties between the glassy and liquid state is not a fixed point, but a range of 17° for Pr alcohol, 30° for propylene glycol, and 40° for glycerol, each individual property having a discrete and abrupt change in this region. A glass may be considered a fourth state of matter having both rigidity and random arrangement; hence its "heat of fusion" is smaller than that of the crystal, whereas its heat capacity is almost identical. On the other hand it may be considered an "isocolloid," a single component existing in 2 or more degrees of dispersion, the colloidally disperse phase being crystalline or amorphous. Again, glasses may be considered from the point of view of liquid crystals, although less profitably. (*C. A.*)

Aqueous solutions of sodium silicates. VII. General summary and theory of constitution. Sodium silicates as colloidal electrolytes. R. W. HARMAN. *Jour. Phys. Chem.*, **32,** 44–60 (1928).—A general summary is given of the work of H. on Na silicates in aqueous solutions. This includes data on conductivity, transfer numbers, activity coefficients, hydrolysis, osmotic activity, freezing point, data, phase relations, and diffusion experiments. It is concluded that but 2 Na silicates exist, *viz.*, Na_2SiO_3 and $NaHSiO_3$. Any other ratios of Na_2O to SiO_2 obtained are examples of colloidal electrolytes. The dissociation constants of silicic acid obtained show it to be a much stronger acid than was formerly supposed. (*C. A.*)

The system: sodium oxide-silica-water. Relationship between composition and boiling point of aqueous solutions of sodium silicate. II. J. Y. CANN AND K. E. GILMORE. *Jour. Phys. Chem.*, **32,** 72–90 (1928).—Using Washburn's apparatus the authors determined the boiling point elevation for different concentrations of Na silicate in aqueous solutions. Commercial "sodium silicates," Na_2O:SiO_2 ranging from 1:1.9 to 1:3.8, are used. The molalities of $(Na_2O)_1(SiO_2)_x$ in the solutions are calculated, plotted against the boiling point elevation, and hence activity coefficients are calculated. The results agree with the freezing point data of Harman. They show that the degree of dissociation falls off in concentrated solutions and that in solutions where the soda to silica ratio is high, micelle formation occurs. Valuable thermodynamic data are presented. (*C. A.*)

The theory of the preparation of silica gels by means of solutions of metallic salts. P. N. GRIGORJEW. *Jour. prakt. Chem.*, **118,** 91–95 (1928).—A review is made of the literature on the reaction between water glass and metallic salt solutions with particular reference to the physical properties of the resulting silica gel. (*C. A.*)

The structure of liquids and vitreous solids. HAROLD JEFFREYS. *Proc. Cambridge Phil. Soc.*, **24,** 19–31 (1928).—The 3 fundamental states of matter are to be regarded as gaseous, crystalline, and vitreous. A vitreous solid is composed of particles held together by the same kind of forces as those in a crystal, but the structure is less regular. There is a correlation between the orientations of neighboring-molecules, though this is not so close as to appear in the properties of the substance in bulk. The stability of

a vitreous solid is comparable with that of a crystal except near the melting point. A liquid is a compromise between the gaseous and vitreous states, consisting of small clotted groups of molecules from 10 to 1000 molecules in linear extent, and possessing considerable freedom of movement. Molecules can migrate under the influence of thermal agitation from one clot to another. Comparison of properties of crystals, vitreous solids, and liquids supports the above conclusions. (*C. A.*)

Regions of reaction. XII. Reaction space Fe-Mg-Al-S. W. P. JORISSEN AND B. L. ONGKIEHONG. *Rec. trav. chim.*, **45**, 849–53 (1927).—Experimental determination of the reaction region Fe-Al-S and Mg-Al-S. The diagrams have been completely obtained. In a third series of experiments Mg has been replaced by several mixtures of Fe and Mg. The results are reported graphically. (*C. A.*)

The dusting of melts in the lime-alumina-silica system. TSUNEO SUZUKI AND KOICHI KASAI. *Sci. Papers, Inst. Phys. Chem. Research* (Tokyo), **7**, 173–88 (1927).—Powdered mixtures of $CaCO_3$, $Al_2O_3 \cdot 3H_2O$, and quartz were fused in an electric arc to balls 5–10 mm. in diameter. After 40 days the quantity of dust finer than a 30-mesh sieve was determined. The compositions which dust are intermediate between blast-furnace slag and Portland cement. Maximum dusting occurs in compositions along the curve through $68CaO+32SiO_2$, $61CaO+29SiO_2+10Al_2O_3$ and $60CaO+20Al_2O_3+20SiO_2$ (molecules per cents). The dust is chiefly $2CaOSiO_2$ in melts low in Al_2O_3 and $3CaO \cdot SiO_2 \cdot Al_2O_3$ in melts higher in Al_2O_3. (*C. A.*)

Accurate determination of specific heats of solids between 0° and 1625°. I. Apparatus and method. F. M. JAEGER AND E. ROSENBOHM. *Verslag Akad. Wetenschappen Amsterdam*, **36**, 763–78 (1927).—A detailed description is given of a metal calorimeter of high precision. The calorimeter proper is a 6000-g., 27×10.1-cm. cylindrical Al block with 5-cm. bore tapered down to 2.7 cm., suspended in a 42×11.5-cm. Dewar vessel. The Al block has 38 holes in 2 concentric circles surrounding the central bore for thermocouples arranged either in series or in parallel, their cold junctions being sealed in a copper ring in the water surrounding the calorimeter. The Dewar vessel is placed in a constant-temperature (20°) vessel of 65×65×81 cm. (650 l. water), closed by a water-filled (29 l.) lid. Constant temperature (to 0.001°) is maintained by means of three Ni heating spirals, a water-cooling coil, and a large thermoregulator, which actuates one heating element by relay action. Three stirrers in agate bearings at the bottom take care of uniformity; one of these circulates water through the lid. The thermo-electric force is measured by potentiometer. For the copper-constantan couples $t=0.00279698E-0.0629E^2$ (E in mv.). Inside the 2.7-cm. hole in the Al block a platinized Al cylinder with conical bore served to catch the dropping heated specimen, which closed the lid on the Al block. By these arrangements the maximum temperature during determinations was reached in a few seconds. The specimens were heated in a Pt resistance furnace placed on top of the calorimeter, and released by fusing the suspending Pt wire immediately after a water-cooled shield in the vertical tube connecting furnace and calorimeter had been withdrawn. The cooling curve of the calorimeter can be extrapolated back to the ideal form, *i.e.*, immediate transfer of heat; for the cooling curve $-\delta e/\delta t = ke$ for e the e.m.f. of the thermocouples and t time. Thus $\log_{10} e_0 = \log_{10} et + k't$ (e_0 at $t=0$). The cooling constant k' can be determined from the measurements at times t_1 and t_2 and was found to be 0.000702 microv. per min. With k' known the initial e_0 and the temperature rise can be calculated. The water equivalent of the calorimeters was found to be 1417.9 ±0.9 cals. **II. Specific heats of platinum and of tungsten.** *Ibid.*, 960–79.—The specific heat of pure Pt (Ir-free) is expressed by $c_p=0.03162+6.1725 \cdot 10^{-6}t+2.3325 \cdot 10^{-10}t^2$, if the Magnus and Gaede value of 0.031186 is used for the mean specific heat between 0° and 20°. The equation holds to 0.1% for t between 150° and 1625°. The results agree well with those of White (accuracy 0.3%)

and they also concur with those at lower temperature (Simon and Zeidler). The atomic heat does not in any way approach a limit at high temperatures for at 1610° the atomic heat is 8.235. The value of the atomic c_v derived from c_p comes up to 7.079 at 1600°; $c_v = 3R = 5.963$ cal. is reached even below 0°. No internal transition of the metal can cause this as proved by X-ray and other evidence. The constant ratio of the linear expansion coefficient α and c_p does not hold; at 0° $(\alpha/c_p)10^6 = 285.6$, at 800° 270.4, at 1600° 261.0. W is easily oxidizable above 600° to WO_3 and at temperatures higher than 900° this oxide yields O_2 to give lower blue and green oxides, which sublime above 1300°. This temperature was therefore the upper limit. From weighings after every experiment and from separate determinations of the specific heats of the oxides the true specific heat of W up to 1300° is $c_p = 0.0274412 + 0.132672 \times 10^{-4}t - 0.091488 \times 10^{-8}t^2 + 0.067812 \times 10^{-11}t^3$ or abbreviated $c_p = 0.02744 + 0.0000132t$. For the crystalline yellow-green oxides formed near 1300° $c_p = 0.0503755 + 0.13644 \times 10^{-3}t - 0.0490476 \times 10^{-6}t^2$. The W specific heat value is quite different from that obtained by other workers by indirect methods (pyrometry) and is believed to be more reliable. The direct values of Magnus and Danz (*C. A.*, **21**, 3534) are considerably higher; these authors used W powder, which is easily oxidized completely at the temperatures investigated (400° to 900°); even heating at 300° gives noticeable oxidation of powdered W. No trace of internal transition of W between 100° and 1300° was found, hence the transition point at 550° from tensile strength measurements (*Phil. Mag.*, **48**, 245 (1924)) is fictitious; this result was confirmed by X-ray patterns. From the c_p values c_v was calcined thermodynamically; the values are again abnormally high (7.998 for atomic heat at 1300°), the "limiting" value 5.963 is reached at 400° and the c_v function rises linearly with t. An equation of Born and Brody for the atomic heat $= 3R(1 - 6\sigma RT)$ does not account for these facts; the σ term should represent thermal expansion, whereas for W and Pt with very small thermal expansion the largest deviations are found.

(*C. A.*)

Boric acids and alkali borates. III. The solid alkali mono- and poly-borates. HEINRICH MENZEL. *Z. anorg. allgem. Chem.*, **166**, 63–98 (1927).—Of the Li borates stable at 30° the monoborate, $LiBO_2 \cdot 8H_2O$ trigonal, can easily be prepared from Li_2CO_3 and boric acid in very pure form; it is recommended as a titration standard and for buffer purposes. Drying overnight in a cool room on a porous plate is sufficient to give a 100% salt. From a dehydration isotherm it appeared that the first 6 molecules of H_2O come off easily (16°), the 7th is lost slowly and the 8th is constitutional water (LiH_2BO_3). The solubility is at 18.0° 22.53 g. $LiBO_2$ in 1000 g. water, at 25.0° 34.6 g. in 1000 g. water. Of the Na borates, $NaBO_2 \cdot 4H_2O$, triclinic, was prepared from borax and soda. Dehydration curves over H_2SO_4 or P_2O_5 caused the monohydrate stage to be approached without intermediary dihydrate. From Debye-Scherrer diagrams the similarity of tetra- and monohydrate and the different structures of anhydrous $NaBO_2$ follow. For the salt, $Na_2B_4O_7 \cdot 10H_2O$, a solubility of 23.24 g. anhydrous salt in 1000 g. water at 18.0°, or 31.55 g. at 25.0° was found. Isothermic drying at room temperature over H_2SO_4 approached the trihydrate stage (no change in X-ray diagram); the structure of "octahedric" pentahydrate stable over 60° is quite different (this salt is actually trigonal). The salt $NaB_3O_3 \cdot 5H_2O$ obtained from a concentrated solution of 1NaOH $+ 4H_3BO_3$ at 30° slowly yields on dehydration at room temperature only one water molecule; the other 4 appear to be constitutional. K monoborate from ignition of boric acid and potash and leaching with dilute KOH is very hygroscopic and corresponds probably to $K_2O \cdot B_2O_3 \cdot 2.5$ or $3H_2O$. The salt $K_2B_4O_7 \cdot 8H_2O$ (10 g. KOH + 22 g. H_3BO_3 in a little warm water) can be dehydrated easily down to 1 molecule of H_2O; the last H_2O molecule comes off slowly. $KB_5O_8 \cdot 4H_2O$ separated easily from solutions of KOH and H_3BO_3 of various concentrations; it is not hygroscopic nor efflorescent; solubility

at 18.0° is 28.32 g. anhydrous salt in 1000 g. water; at 25.0°, 35.32 g. It loses practically no water over H_2SO_4 at room temperature, all 4 molecules are constitutional. "Potassium pentaborate," $K_2HB_5O_9 \cdot 2H_2O$, was prepared according to Auger; it is stable between 115° and 120°. Considered as $2K_2O \cdot 5B_2O_3 \cdot 5H_2O$ it loses easily 4 molecules H_2O. NH_4 tetraborate, $(NH_4)_2B_4O_7 \cdot 4H_2O$, by slow crystallization of a warm solution of 24 g. H_3BO_3 in 110 g. 15% NH_3 and 25 g. water has a noticeable NH_3 tension. Its solubility is at 18.0° 72.7 g. anhydrous salt in 1000 g. water, at 25.0° 96.0 g. For all its samples and for its solution was found an NH_3 content 2 to 3% too high, water too low. NH_4 pentaborate, $NH_4B_5O_8 \cdot 4H_2O$, from a hot solution of 18 g. boric acid in 30 g. water and 11 g. 15% NH_3, rhombic bipyramidal, has a solubility at 18° of 70.3 g. at 25°, of 87.2 g. anhydrous salt per 1000 g. water; it does not give off NH_3. Dehydration experiments over Na_2O_2 showed the $4H_2O$ molecules to be as firmly bound as those of the corresponding K salt. Experiments under pressure or in a stream of NH_3 at low temperatures for the preparation of a NH_4 monoborate were unsuccessful, the best products obtained had ratios 1:1.42:2 for $(NH_4)_2O:B_2O_3:H_2O$, *i.e.*, probably tetraborate with one crystal H_2O replaced by NH_3. The salt properties are discussed on the basis of structural formulas of the borates with either tervalent B or ionogen quadrivalent B.

IV. Solid alkali perborates. *Ibid.*, **167**, 193–229.—Riesenfeld and Leblanc have differentiated between true persalts (which liberate I from cold 25% KI solution), pseudopersalts (which have no reaction with KI), complex bound H_2O, and compounds that give O_2 in contact with cold KI solution. For various reasons, simultaneous O_2 and I liberation, solubility and hydrolysis effects, M. takes exception to this view. Rather than being a constitutional test the Riesenfeld test is the result of several complex factors. The salt, $LiBO_2 \cdot 2H_2O$ (or $LiBO_2 \cdot H_2O_2 \cdot H_2O$), was prepared from 20 g. Li monoborate octahydrate with 17 g. perhydrol in 120 g. water dissolved at 0° and precipitated after several hours by a double volume of EtOH at 0°. After several days of kneading and drying the substance was obtained in air-dry form; the Riesenfeld test shows weak O_2 liberation at 0° and little free I. Prolonged standing causes water and active O to disappear; P_2O_5 removes one water molecule, the resulting anhydrous $LiBO_2 \cdot H_2O_2$ is also stable. At 18° $LiBO_2 \cdot H_2O_2 \cdot H_2O$ is easily soluble (more than 1.5 *M*), but separates $LiBO_2 \cdot H_2O_2$ of lower solubility (about 0.23 *M*). The Debye-Scherrer diagrams of both salts are identical. The anhydrous salt dried at 50° for 24 hrs. undecomposed changes abruptly at 117° and 15 mm. vacuum; an exothermic reaction causes the substance to heat and lose part of its O. Heating up to 250° drives out all active O. This behavior is very similar to that of the Na salt, studied by Geigenmüller (*Dissertation*, Dresden 1920). Efforts to prepare true Na perborate (Leblanc and Zellermann) were unsuccessful. Preparation of the approximate composition $KBO_3 \cdot 0.5H_2O$ were obtained according to the method of von Girsewald and Wolokitin; they give both O_2 and I at 0°; the distinction between separate pseudo and true K perborates (Leblanc) could not be confirmed. The solubility is about 0.45 *M* at room temperature. Drying at 50° yielded again undecomposed $KBO_3 \cdot 0.5H_2O$; further heating *in vacuo* up to 250° removed the active O. M. rejects a constitution for this salt of mixed KBO_3 and $KBO_2 \cdot H_2O_2$ but attributes the peculiar Riesenfeld reaction to the semihydrate state, essential to this salt type. Dissolution of 12.4 g. H_3BO_3 in 250 cc. 3% H_2O_2 + 25 g. 15% NH_3 and precipitation with a double volume EtOH yielded NH_4 perborate (15 g.) $NH_4BO_3 \cdot 0.5H_2O$; the Riesenfeld reaction gives little O_2 and much I. It gives off NH_3 and O_2 to the air and absorbs water. Dehydration over non-acid desiccants always gives the semihydrate; its solubility is about 0.40 to 0.45 *M*. Drying in air at 50° to 55° causes NH_3 to be evolved and half of the water; heating *in vacuo* over 115° causes explosive decomposition; at 250° only B_2O_3 is left. On the basis of Hermans' theory it is assumed that the perborates studied are either salts of an anion $B_2O_8 \cdot 2H_2O$, or of an

anion $B_2O_6 \cdot H_2O$, each having 2 coördinately quadrivalent B atoms. The properties are discussed on the basis of the structural formulas proposed. (*C. A.*)

Determination of the value of adsorbents. WILHELM BACHMANN AND LUDWIG MAIER. *Z. anorg. allgem. Chem.*, **168**, 61–72 (1927).—In order to measure the activity of adsorbents, like SiO_2, toward vapors, the customary determination of the sorption maximum is not sufficient. The whole sorption and desorption curves should be drawn to obtain a true image of the technical value of the adsorbent. The sorption and desorption curves of SiO_2 have been determined by the method previously used for charcoal and coconut coal. A very accurate diagram was obtained. The curves show the characteristic hysteresis type of the Van Bemmelen cycle of SiO_2 gels. The method described may be applied to technical adsorbents. (*C. A.*)

BOOKS

Treatise on Inorganic and Theoretical Chemistry. Vol. VIII. Nitrogen, Phosphorus. J. W. MELLOR. Longmans, Green & Co., New York, 1928. x+1110 pp., 156 figures. Price $20.00. Reviewed in *Jour. Amer. Chem. Soc.*, **50** [5], 1511 (1928). R.J.P.

Elementary Physical Chemistry. (Adapted from a treatise on "Physical Chemistry.") HUGH S. TAYLOR. D. Van Nostrand Co., Inc., New York, 1927. ix+531 pp., 108 figures. Price $3.75. Reviewed in *Jour. Amer. Chem. Soc.*, **50** [5], 1512 (1928). R.J.P.

Publications from the Kaiser Wilhelm Institute for Silicate Research. Edited by William Eitel. Gebrüder Borntraeger, Berlin, 1928. vi+262 pp., 55 figures. Price, unbound, 28M. Reviewed in *Jour. Amer. Chem. Soc.*, **50** [5], 1513 (1928).—This volume is the first of a series of collected publications of the Kaiser Wilhelm Institute for Silicate Research under the direction of Wilhelm Eitel. Most of the articles are concerned with crystallographic analysis by means of X-rays of various minerals and of a few organic substances but the longest article and the one of most general interest is one by E. Herlinger, entitled "Concerning the Newer Developments of Geochemistry." The volume should constitute a useful collection for mineralogists, chemists, and geologists interested in the chemistry and the physics of the silicates. R.J.P.

Industrial Catalysis. STANLEY J. GREEN. 500 pp. Ernest Benn, Ltd., London, 1928. Price 45*s*. H.H.S.

Stereoscopic Drawings of Crystal Structures. M. VON LAUE AND R. VON MISES. Blackie & Son, Ltd., London, 1928. Price 15*s*.—A series of 24 stereoscopic drawings, with descriptive booklet, prepared to show the spatial illations of the atoms in typical crystals. An ordinary stereoscope can be used for their examination. H.H.S.

Report of the National Physical Laboratory for 1927. London, H. M. Stationery Office, 1928. Price 7*s* 6*d*. H.H.S.

Handbook for practical chemists. Wilhelm Ernst and Son, Berlin, 1928. 2nd ed., 898 pp. Price 28 RM.—This book deals with (1) the chemical industries of the world; (2) the properties of substances; (3) states of aggregation, plant, physics and physical chemistry, and chemical technique. H.H.S.

Progress of Applied Chemistry: Annual Report, 1927. London: Society of Chemical Industry, 1928. Price 12*s* 6*d*.—The section on glass is by A. Cousen, and that on refractories, ceramics, and cement by A. T. Green. Other sections are: general, plant, and machinery; fuel; gas, carbonization, tar, and tar products; mineral oils; coloring matters and dyes; fibers, textiles, cellulose, and paper; bleaching, dyeing, printing, and finishing; acids, alkalis, salts, etc.; iron and steel; nonferrous metallurgy; electro-industries; oils, fats, and waxes; paints, pigments, varnishes, and resins; india-rubber; leather and glue; soils and fertilizers; sugars, starches, and gums; fermentation industries; foods; sanitation, water purification, etc.; fine chemicals, medicinal substances, and essential oils; photographic materials and processes. H.H.S.

Colloid Symposium Monograph. Vol. 5. Edited by H. B. Weiser. Chemical Catalog Co., New York, 1928. Price $6.50.—A collection of the papers presented at the fifth national symposium on colloid chemistry at the University of Michigan in June, 1927. H.H.S.

Physico-Chemical Fundamentals of Chemical Technology. GEORG-MARIA SCHWAB. Otto Spanner, Leipzig, 1927, viii+130 pp. *Tonind. Ztg.*, **52** [2], 29(1928). F.P.H.

PATENTS

Process of preparing an artificial base exchange substance and the product thereof. EDWIN M. PARTRIDGE AND ELWOOD W. SCARRITT. U. S. 1,656,604, Jan. 17, 1928. The process which consists in preparing a wet mixture of sodium silicate and trisodium phosphate, separately preparing a wet mixture of aluminum sulphate and magnesium sulphate, combining the two mixtures to precipitate insoluble magnesium phosphate and to form a gel, and drying the latter at a relatively low temperature.

Process of making beryllium and aluminum oxides. CHARLES F. BRUSH, Jr. U. S. 1,656,660, Jan. 17, 1928. In the process of making beryllium oxide from beryllium minerals containing aluminum, the steps of converting the beryllium and aluminum into sulphates, freeing a mixture of these sulphates from other substances, and igniting the mixture of sulphates to produce a mixture of the corresponding oxides.

Separation of hafnium and zirconium. ANTON EDUARD VAN ARKEL AND JAN HENDRIK DE BOER. U. S. 1,666,800, April 17, 1928. The process of separating compounds of hafnium and zirconium, characterized by starting from the solution of the complex compounds that can be prepared by adding in an acid medium fluorine ions and cations corresponding to the cations of the desired complex compounds to a mixture of hafnium and zirconium salts, which can be derived from the at least trivalent oxides of the elements the atomic number of which is 18n—3 if n is a whole number and at most 3, and that the solution of the complex compounds is submitted to fractional separation.

Separation of hafnium and zirconium. JAN HENDRIK DE BOER. U. S. 1,666,811, April 17, 1928. A process of separating hafnium and zirconium by starting from a solution that can be obtained by bringing a mixture of phosphates of hafnium and zirconium in a medium containing concentrated sulphuric acid, characterized by adding to the solution at least one other salt of hafnium and zirconium.

Zinc oxide catalysts. GROVER BLOOMFIELD. U. S. 1,668,838, May 8, 1928. A process for preparing a catalyst which comprises combining zinc oxide with a solution of ammonium nitrate, and igniting the mass.

Manufacture of lithopone. WILLIAM H. LANDERS. U. S. 1,669,476, May 15, 1928. The improvement in the process of making lithopone, which comprises feeding undried lithopone into one end of an elongated slightly inclined furnace, rotating the furnace to cause the lithopone to move toward the other end of the furnace, introducing combustible gas into the furnace at the end opposite that at which the lithopone is introduced, burning the gas in the presence of air in insufficient quantity to completely consume the gas, whereby the lithopone is first dried, then preheated, and finally calcined, introducing air into the furnace between the calcining portion and the feed end thereof.

Phenol resin. CHARLES J. ROMIEUX. U. S. 1,669,674, May 15, 1928. A method of making potentially reactive condensation products which comprises providing a mixture of a phenol boiling above 202°C and formaldehyde, adding alkali to an amount less than .1% based on the phenol present thereto and causing a reaction therebetween to produce a reactive resin.

Improved method of manufacturing crude lithopone. JOHN H. CALBECK. U. S. 1,669,857, May 15, 1928. In the manufacture of lithopone the method of producing crude lithopone of high quality which consists in continuously running aqueous solutions of zinc sulphate and of barium sulphide in reactive proportions into a precipitating and

mixing tank, energetically stirring the contents of the tank, continuously drawing off the contents in such manner as to maintain an approximately constant level therein and approximately constant concentration of the liquid contents thereof and settling out a lithopone pulp from the mixture drawn from the tank.

Recovery of alumina and phosphates from aluminium phosphates. L. MELLERSH-JACKSON. Brit. 283,072, June 24, 1927. Aluminium phosphates are mixed with oxides, carbonates, sulphates, or chlorides of alkaline-earth metals and with alkali salts in the proportion of 1 mol P_2O_5 to 2 mols alkaline-earth metal oxide and 1 mol of alkali oxide, and 1 mol of alumina to 1 mol of alkali oxide, and are heated at 900° or over, the soluble alkali aluminate being extracted with water and the alumina worked up, while the phosphate residue is used as a fertilizer. If sulphates or chlorides are used the process is carried out in the presence of steam produced from fuels rich in hydrogen, *e.g.*, water-gas, oil, etc. (*B. C. A.*)

Treatment of leucite and like minerals. P. SPENCE AND SONS, LTD., AND T. J. I. CRAIG. Brit. 283,087, June 29, 1926. Minerals containing aluminium and potassium oxides are treated with nitric acid, a neutral or basic solution being obtained by removal of free nitric acid and some of the combined acid by heat or by neutralizing with alumina or potash, after which iron is eliminated as basic ferric potassium sulphate or by digesting with manganese dioxide, tin oxide, or antimony oxide. The potassium nitrate is separated by crystallizing under regulated conditions of temperature and specific gravity and is washed with a saturated solution of potassium nitrate. Nitric acid is added to the mother-liquor and the aluminium nitrate separated. The mixed nitrates may be cooled below the temperature at which mixed potassium nitrate and aluminium nitrate crystals are formed, and rewarmed to dissolve the aluminium nitrate crystals. (*B. C. A.*)

Chromium. GENERAL ELECTRIC CO., LTD. Brit. 285,571, April 12, 1928. Coherent bodies of chromium are produced by pressing the powdered material into bars and sintering them in pure hydrogen at a temperature of 1500–1550°C. The chromium powder may be prepared by passing an electric current of about 140 amperes per square decimeter through a solution containing 24.5% chromic acid and 0.3% chromic sulphate, using an anode of lead and a cathode of copper or aluminium, the solution being at a temperature of 50°C. The cathode is preferably surrounded by a porous pot in which the chromium collects. The powder is washed and dried and heated at 1300°C in pure hydrogen to reduce any oxide present. The hydrogen may be purified by passing it over incandescent tungsten, and through a tube cooled in liquid oxygen, with or without a previous passage over red hot copper and phosphorus pentoxide.

Catalytic agents. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 286,123, April 25, 1928. The process according to which metallic catalysts, particularly those promoting hydrogenation and reduction, are prepared by separating the metal in a finely subdivided form from aqueous solutions of its salts by means of a more electropositive metal, is modified in that the separation is effected in the presence of an organic base or an acid amide. The operation may be conducted under ordinary or elevated pressure, and a carrier, such as kieselguhr, silica gel, or animal charcoal, may be present. The separation may be brought about by hydrogen instead of by a metal, and in this event an addition of metal may be made to hasten the separation. In one example, an aqueous solution of nickel chloride is mixed with pyridine and the mixture is warmed and treated gradually with zinc dust, whereafter the precipitated nickel is filtered, heated with sodium carbonate solution, separated, and washed. In another example, an aqueous solution of cobalt sulphate mixed with urea is treated similarly. In a further example, an aqueous solution of nickel sulphate is mixed with pyridine, kieselguhr, and finely divided nickel and the mixture is treated in an autoclave with hydrogen under a pressure of 30–40 atmospheres and at a temperature of 100°C.

Potassium carbonate and other salts. J. H. BREGEAT. Brit. 286,172, April 25, 1928. Potassium chloride is converted into potassium silicate with liberation of hydrochloric acid by heating with silica. The silicate is dissolved in water and treated with carbon dioxide to yield potassium carbonate and precipitate silica, which is used again. The carbonate may be treated to yield other salts either with an acid, for example sulphuric acid to yield potassium sulphate or by double decomposition, for example with calcium nitrate to yield potassium nitrate. The heating of the chloride with silica is effected in an electric or other furnace, and charcoal may be added to facilitate the subsequent solution in water.

General

Society consciousness. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [5], 119–20 (1928). —For successful organizations it is necessary that the individuals composing them be kept to maximum of effort in self-development, coöperation, and directing the efforts of both to best development in the mutual objective of both. The success of the AMERICAN CERAMIC SOCIETY is dependent on the amount of thought and service given by its individual members. E.J.V.

Ceramic library and museum. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [5], 120–21 (1928).—The value of a ceramic library and museum at the headquarters of the AMERICAN CERAMIC SOCIETY is discussed. A means of collecting one by the coöperation of the members is suggested. E.J.V.

The modern color wave. REXFORD DANIELS. *Ceram. Ind.*, **10** [5], 525–27 (1928); *Pottery, Glass and Brass Salesman*, **37** [13], 17 (1928); reprinted from *Printer's Ink*.—D. displays an excellent insight on the workings of the colored-ware consumer's mind, and offers some fundamental rules to follow when dealing with the color consciousness of the modern public. F.P.H.

Clay mining and manufacture in Ohio: a technical survey. G. A. BOLE AND H. E. NOLD. Ohio State Univ., Eng. Expt. Sta., *Circ.*, No. 14. May (1928).—This circular is a preliminary report of information obtained in a recent investigation of the heavy clay

TABLE I
Clay mining
(Tons Per Man Per Day)

	Underground			Open Pit			
	Max.	Min.	Av.	Max.	Min.	Av.	
Face brick	14.0	4.2	9.6	97.5	20.0	49.5	Power shovel
				18.7	10.0	14.3	Hand loading
Common brick				34.0	14.0	23.8	Horse and scraper
				105.0	18 0	58.1	Power shovel
				105.0	23.0	64.7	Power shovel (shale only)
				96.0	18.0	54.6	Mechanical loading (surface clay only)
Hollow tile	15.0	4.7	12.1	73.0	30.0	47.9	Power shovel (shale)
				17.0	12.0	15.2	Hand loading (shale)
				25.0	22.5	23.1	Power shovel (fire clay)
Sewer pipe	15.6	5.0	9.5	56.0	12.0	36.9	Power shovel
				13.7	7.9	10.8	Hand loading
Pavers				111.0	20.0	53.2	Power shovel
Refractories	17.0	3.0	11.1	26.7	21.0	24.1	Power shovel
				10.0	4.0	8.3	Hand loading

products and refractories plants of Ohio. This material should help manufacturers to compare their operation with that of other plants in the state. From a technical standpoint (leaving out marketing, etc.) the outstanding difficulties of the heavy clay products and refractories industry in Ohio appear to be: (1) overdevelopment, (2) uneconomical mining of clay and shale, (3) inefficient forming plant practice, (4) uneconomical firing. These difficulties are discussed in order. Table I gives the production of the various types of mines in tons of clay per mine employee per day. In arranging this table, the mine employees were made to include all labor necessary to deliver the clay into storage ready for the manufacturing plant. Figures are given for each of the industries except drain tile where the rotation of labor from one job to another, except in the case of a few of the larger plants, makes accurate allocation of mine (pit) labor impossible.

TABLE II

Fabrication

(Units Per Man Per Day)

	Max.	Min.	Av.
Face brick (thousands)	1.75	0.33	0.96
Common brick (thousands)			
Soft mud	1.80	0.66	1.30
Stiff mud	2.50	0.73	1.30
Pavers (thousands)	1.10	0.47	0.82
Refractories (thousand 9")			
Hand made	0.45	0.35	0.38
Machine made	1.10	0.40	0.89
Building tile (tons)	4.72	1.50	2.84
Sewer pipe (tons)	1.42	0.77	1.10
*Drain pipe (tons)	2.40	0.98	1.49

* Note: Total men (include clay mining).

In Table II are shown plant production (fabrication) figures. These data include all labor items from the time the clay is delivered to the forming plant until it is loaded on the railroad cars at other transportation units. The units used are thousands as in the case of brick and tons in the case of hollow ware. Here, as in mining, is seen a wide variation between the minimum and maximum figures. The variations from the weighted averages are a more significant figure. It will be noted that, within industries where machine fabrication is employed and in which comparisons are fair, the widest variation between minimum and maximum production per man is 5 to 1, while the least variation is 2 to 1.

TABLE III

Fuel consumption

(Pounds of coal per unit of ware)

	Up to 1900°F			1900–2100°F			Above 2100°F		
	Low	High	Av.	Low	High	Av.	Low	High	Av.
Face brick	800M	1500M	1320M	1000M	2000M	1420M	1200M	2500M	1700M
Common brick	500M	1900M	960M						
Paving brick	1970M	2040M	2000M	1260M	3500M	2500M	2500M	3500M	3000M
Refractories							1300M	3000M	1925M
Building tile	350T	750T	435T	360T	1300T	595T	520T	900T	650T
Sewer pipe				660T	1400T	960T	660T	1000T	880 T
Drain tile	300T	700T	470T						

NOTE: 800M means 800 lbs. of coal required to fire 1000 brick. 350T means that 350 lbs. of coal were required to fire one ton of ware. (Data do not include R. R. tunnel kiln operation).

Tables III and IV summarize results obtained in firing practice in Ohio. Fuel consumption and firing time are given for plants firing the ware at low, medium, and high temperatures. The data cover several plants in each class. Vacant spaces in the tables indicate that no plants are firing at those particular ranges.

TABLE IV
Firing Time

	Up to 1900°F			1900–2100°F			Above 2100°F		
	Low	High	Av.	Low	High	Av.	Low	High	Av.
Face brick	4	11	7	6	12	7½	6	9	8
Common brick	4	13	8						
Paving brick	11	13	12	6	8	7	7½	8	8
Refractories							5	15	8
Building tile	2¼	4	3	2	5½	3	2½	5½	3½
Drain tile	2	6	3						
Sewer pipe				3	8½	5	2½	9	4½

Some figures on tunnel kiln practice—not all from the Ohio survey are given in tabular form below:

TABLE V

Type of fuel	Product	Temperature (°F)	Quality of fuel per 1000 Br
Gas (10,000 B.t.u.)	Face brick	1900	5500–6000 cu. ft.
Oil (19,000 B.t.u.)	Face brick	1850	35 gals.
Oil (19,000 B.t.u.)	Refractories	2250	80 gals.
Coal (12,000 B.t.u.)	Common brick	1900	450 lbs.
Coal (12,000 B.t.u.)	Refractories	2200	1000 lbs.
Powdered Coal (13,000 B.t.u.)	Hollow brick	1900	340 lbs.

F.P.H.

Practical cost methods for manufacturers of clay products. VI. W. H. COMPTON. *Ceram. Age*, **11** [4], 134–35 (1928).—Production figures, a balance sheet, and a statement of income and profit and loss should be furnished the executives as soon as possible after the close of each month's business. C. gives typical forms. For comparative purposes, graphic charts are of great use. A typical chart of this kind is shown and reasons why interest on investment should not be charged in arriving at the cost of the product, although this is a controversial point. For preceding abstracts see *Ceram. Abs.*, **7** [6], 412 (1928). A.E.R.W.

Effect of titanic oxide on clay. ANON. *Brit. Clayworker*, **37** [432], 17 (1928). Reprinted from *Staat. Forsch. Inst. für Keramik* (Leningrad).—Some effects of the presence of titanic acid in fire clays are as follows: (1) titanic oxide can produce a bluish discoloration in clay when the latter is heated in a kiln; (2) the intensity of the color is roughly proportional to the percentage of titanic oxide present; (3) the color is intensified by heating under reducing conditions; (4) in the presence of iron compounds or of an excess of bases the blue color is easily discharged; (5) under normal conditions of firing the color is only formed after vitrification begins; (6) if more than 6% of titanium oxide is present the resulting color is not blue but yellow. R.A.H.

Official changes in the active list of permissible explosives. ANON. Bur. Mines, *Report of Invest.*, Serial No. 2864 (1928).—The following permissible explosives were transferred from the active list to the inactive list of permissible explosives. Trojan coal powders M-1, M-4, and J; Atlas E, L.F.; Atlas E, L.F. special; Giant E, L.F.; Giant E, L.F. special; Grasselli No. 8 L.F., and Mine-Gel No. 1. R.A.H.

Langmuir's work. W. R. WHITNEY. *Ind. Eng. Chem.*, **20** [3], 329–32 (1928).—An appreciation of the work done by Langmuir given in an address at the Perkin Medal award. R.J.P.

Atomic hydrogen as an aid to industrial research. IRVING LANGMUIR. *Ind. Eng. Chem.*, **20** [3], 332–36 (1928).—An address by the recipient of the Perkin Medal given at the time of the award. R.J.P.

Thermodynamics in the service of technology. MERLE RANDALL. *Ind. Eng. Chem.*, **20** [4], 344–48 (1928).—An address in which the application of thermodynamics

to industry in many phases is discussed. The data gathered by many investigators are considered and the practical application to particular industries is pointed out. R.J.P.

Building materials. Census. ANON. *Chem. and Ind.*, **47**, 419 (1928).—The total value of goods (besides glass) made in the building materials, monumental masonry, roofing, and flax felt trades, was £12,038,000 in 1924 and £2,692,000 in 1907. The 1927 figures include Ireland; the 1924 figures are for Great Britain only. The net output per head was £238 in 1924, compared with £94 in 1907. H.H.S.

New books on science. ANON. *Chem. and Ind.*, **47** [18], 459–82 (1928).—This is a spring review number of books published in English, German, and French: (*a*) 44 books are reviewed, among them Sosman's "Properties of Silica" and Comber's "Scientific Study of the Soil"; (*b*) a classified list of books reviewed during the last six months, and (*c*) new and forthcoming books of the leading English and American publishers. H.H.S.

Japanese Engineering Congress (Kogakkai). ANON. *Science*, **67**, 191, 235 (1928). —The first general meeting of the Kogakkai was held at the Tokyo Imperial Univ.; more than 5000 engineers attended. The Kogakkai is made up of 12 affiliated societies of the various branches of engineers. Addresses from government officials were given and 160 papers read. The International Engineering Congress will be held at Tokyo in October, 1929, under the auspices of the Kogakkai. H.H.S.

National Research Council of Italy. J. W. LIEB. *Science*, **67**, 233 (1928).—A National Research Council has been in existence in Italy since 1921, but owing to its peculiar organization it has not been able to obtain all the expected results. Mussolini has therefore directed to Marconi, the president of the council, a message (here translated by L.) fixing the constitution and fundamental objectives of the Council. The communication is regarded as ranking, for the scientific and technical development of Italy, with the speech of Pesaro, which began the economic rehabitation of the country. H.H.S.

Colorimetric methods. F. B. SUMNER. *Science*, **67**, 271 (1928).—The Ives tint photometer has been adapted and standardized by S. The new procedure is especially suitable for measuring color and shade of out-of-doors and of living animals. H.H.S.

Building materials production in Canada sets new high record. DOMINION BUREAU OF STATISTICS. *Contract Rec. and Eng. Rev.*, **42** [15], 379–82 (1928).—At $42,886,492 the clay products, brick, tile, etc., and other structural materials produced during 1927 attained a total value higher than for any previous year. The price of cement declined, but the production was much higher, so that the value was $14,391,897 as compared with a total of $13,013,283 in 1926. Production of brick and clay products increased 6.2% in value over the preceding year. Lime output reached a value of $3,927,084. This report includes production figures for all of the nonmetallics produced in Canada. L.P.C.

British glass trade in 1926. ANON. *Glass*, **4** [2], 78–80 (1927).—Graphs and tables show the relations of price and quantity between exports and imports. A.J.M.

BOOK

National Research Council of Canada: Annual Report. H. M. TORY. F. A. Acland, Ottawa, 1928. Price 25 cents.—The completion of the 10th year of existence of the Research Council affords an opportunity of adding two new sections to the report: (1) reviewing the history, organization, and accomplishments of the council during the past decade, (2) surveying the present position of research throughout the industrial nations of the world. Among the reports of assisted researches occur papers on the tar sands of Alberta, deterioration of concrete in alkali soils, the precipitation of iron and

silica under natural conditions, the surface energy of solids, the impact resistance of iron and steel, the efficiency of screening, and power losses in dielectrics. H.H.S.

PATENT

Process of manufacturing ceramic products. LUDWIG KERN. U. S. 1,666,936, April 24, 1928. In the manufacture of molded articles, the herein described improvement which comprises adding to a sand and hydrated lime mixture, a substantial amount of hydrated silicic acid, molding the mixture under pressure, and indurating the product under superatmospheric pressure with an elastic fluid capable of entering into reaction and produce a hardening of the molded article.

Book Reviews

The Constitution of Glass. Edited by W. E. S. Turner. Published by the Society of Glass Technology. The present volume consists of papers which have already appeared in the pages of the *Journal of the Society of Glass Technology*. In explanation of the work, T. says:

> The subject of the constitution of glass is one in which, hitherto, there has been no adequate guiding theory. It is obvious, therefore, that it may be approached from different directions, a fact which provided warrant for publishing under a single title a series of papers of very diverse character. And at least there is some advantage in allowing individual authorities to have free rein in presenting their own personal views. Despite the fact that the present volume lacks the systematic presentation which a single author or compiler may have given to it, there are few aspects of the subject which do not find reference in one or other of the papers. It is hoped that the publication of the volume may stimulate additional investigators to enter a field so fascinating and so comparatively virgin.

The subjects of the several chapters are as follows: (1) "The Nature and Constitution of Glass," by W. E. S. Turner; (2) "Glasses as Supercooled Liquids," by G. Tammann; (3) "Constitution and Density of Glass," by A. Q. Tool and E. E. Hill; (4) "Viscosity and Allotropy of Glass," by Henri Le Chatelier; (5) "The Viscosity of Glass," by V. H. Stott; (6) "The Ternary System Sodium Metasilicate-Calcium Metasilicate-Silica," by G. W. Morey and N. L. Bowen; (7) "X-Ray Diffraction Measurements on Some Soda-Lime-Silica Glasses," by R. W. G. Wyckoff and G. W. Morey; (8) "Some Remarks on the Constitution of Glass," by F. Eckert; (9) "The Structure of Quartz," by W. H. Bragg; (10) General Discussion on the Foregoing Papers; (11) "The Viscous Properties of Glass," by V. H. Stott; (12) "The Structure and Constitution of Glass," by W. Rosenhain.

The editor is to be commended for having brought together in a single volume this important series of papers, constituting a very complete discussion of present day knowledge of the constitution of glass. These discussions are presented by well-known specialists in several different branches of science, and the book will be read with more interest by and probably will be of more value to the research worker or pure ceramist than to the technologist. The work is significant of the trend of thought in glass technology and the progressive glass manufacturer should of course keep himself informed of such developments. Certainly the scientifically trained man, in the industry or in the university, will find in this volume a readable source of information upon a subject that may well be of very practical value when the facts of the constitution of glass shall be made clear. E. W. TILLOTSON

The Manufacture of Stoneware Pipe. W. SCHUEN. Published by Tonindustrie-Zeitung, Berlin, 1928. 113 pp., 59 illustrations, and 7 tables. Price 5RM. The literature on stoneware is small, and a book from the standpoint of the practical man,

written for the practical man, has not appeared since the comprehensive work of Kerl, "Handbuch der gesamten Tonenwarenindustrie," edited by E. H. Cramer and Hermann Hecht, which is no longer obtainable from publishing houses. This book will fill a demand at this time. S. is especially fitted for this work, being manager of a stoneware factory. The steps in the manufacturing process form the systematic outline of the text. The raw materials are first treated as the basis of the entire subject. Clay and grog are distinguished. It is the function of the grog (fired pipe grog, porcelain grog, and lump clay fired to blue grog) to depress the frequently too high drying and firing rate of otherwise excellent stoneware clays to the desired value. The suitability of clays is judged chiefly on the basis of firing behavior (sintering point between Seger cones 1–6, deformation point above Seger cones 28–29), chemical composition, and softening behavior at high temperatures under pressure. Practical experiment always governs the final decision. Because of its expense, the practical test should be preceded by calculations and laboratory experiments. The next section deals with the preparation of the materials. Numerous sketches are provided for both the wet and dry processes and the advantages and disadvantages of both systems are compared. Special attention is given to working out methods of replacing human labor by machines at such places where this is possible. The presentation of the various types of mechanical aids is especially distinguished by the fact, that it goes far beyond the usual presentation, indicates the weak points of construction much more extensively than has previously been done, and emphasizes the measures which have hitherto been developed for the elimination of defective procedure. The section on forming shows the advantages of mechanical after-treatment of the pressed and dried pipe, and comprehensively describes the Ooms process as the hitherto most satisfactory solution of the problem of mechanical forming. The forming of elbows, branches, pickling vats, saggers, and shed articles, etc., is also taken up. In the discussion of the dry process the author points out the advantages of artificial drying with moist air. Chapter V, "The Firing," demands especial consideration. Under the heading of practical observations and scientific applications is depicted the behavior of the stoneware body during firing and salting; also the supervision of the firing by means of temperature measuring instruments, chimney gas measurers, and flue gas measurers; also the construction of firing curves. The section on "Firing Process" contains sketches of kilns with recuperator and regenerative firing, a field which the entire ceramic industry, insofar as it is concerned with single chamber kilns, must consider with necessarily increasing interest, since a thermal efficiency of 7–8% cannot be permanently endured. Methods of calculation and formulas for tentative construction, tables, diagrams, and values are given as a basis for the numerical evaluation of the firing process. After the discussion of firing, S. outlines and illustrates the defects of stoneware which result from harmful constituents in the raw materials or defective processing. The properties of stoneware, its field of application, a chapter on silicate chemistry, and a few well compiled tables form the conclusion of the book.

The Properties of Silica. (An Introduction to the Properties of Substances in the Solid Nonconducting State.) ROBERT B. SOSMAN. 836 pp. No. 37, Monograph Series, Amer. Chem. Soc. Price $12.50. The Chemical Catalogue Co., New York. The fact that this work deals only with pure silica shows the thoroughness with which S. has treated the matter. Two facts are outstanding: (1) the voluminous literature on silica, and (2) the very excellent manner in which the data are summarized and correlated. Concerning this S. states:

The compilation of the material was not very difficult, but what did it all mean? During these past two decades our knowledge of the structure of matter and the properties of energy had progressed tremendously. The desirability of relating the collected

facts to the new general principles, and of giving the whole assemblage a more thorough and fundamental treatment than had first been planned, became more and more evident as the work advanced.

The confusion that has been caused by using the Greek-letter prefixes for the various modifications of quartz, cristobalite, and tridymite is avoided by the author by calling the modifications "high-quartz" and "low-quartz"; "high-cristobalite" and "low-cristobalite"; "upper high-tridymite," "lower high-tridymite" and "low-tridymite," these terms being abbreviated forms of "high-temperature quartz," etc. S. rightfully condemns the use of the word "quartz" in referring to vitreous silica. The book is divided into eight parts and the principal subjects treated may be summarized as follows: (1) The properties of a substance and the composition and constitution of silica. (2*a*) The principal forms, (*b*) the various inversions, (*c*) the micro-forms and inversions of these forms. (3*a*) Symmetry and structure, (*b*) general theory of the structure and polymorphism of silica, (*c*) the density of silica. (4*a*) The storage of thermal energy, (*b*) thermal changes in volume and shape, (*c*) the flow of thermal energy. (5*a*) Elastic properties, (*b*) flow and failure, (*c*) surface energy. (6*a*) Silica in the electric and magnetic fields, (*b*) piezo-electric and pyro-electric properties of silica. (7*a*) Silica in the periodic electromagnetic field, (*b*) rotatory power, (*c*) refraction, (*d*) absorption and emission, (*e*) theoretical aspects of the radiational properties, (*f*) electro- and magneto-radiational properties. (8*a*) Geological applications, (*b*) industrial applications of silica, (*c*) silica refractories, (*d*) the manufacture of vitreous silica, (*e*) chemical and physical uses of silica. The book has an excellent index and glossary, and is very highly recommended to the research worker in the field of silicates.

F.P.H.

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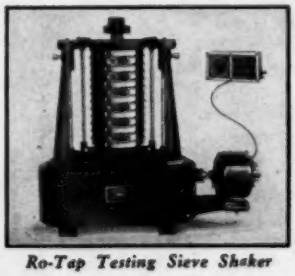

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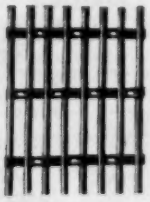

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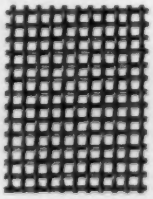

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Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering COLUMBUS, OHIO

Founded 1895

Curriculum—Ceramic engineering and technology. Advanced research in cooperation with State owned plants and Federal Government.

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Founded 1900

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering URBANA, ILLINOIS

Founded 1905

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products.

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Founded 1906

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate.

THREE INSTRUCTORS *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Founded 1910

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering SEATTLE, WASHINGTON

Founded 1918

Curriculum—General ceramic engineering with research in ceramics and non-metallics.

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Founded 1921

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Founded 1923

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW — *Instructor:* GEO. J. BAIR

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT

Founded 1923

Curriculum—Ceramic Technology and Engineering

TWO INSTRUCTORS — *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923

Curriculum—Ceramic Engineering

TWO INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—students selection of ceramics includes chemical and engineering principles applied to ceramic manufacture.

TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827. Department of Metallurgy, Ceramic Division, 1925.

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Founded 1926

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering

Head of Department: J. W. WHITTEMORE

THE OHIO STATE UNIVERSITY

Department of Fine Arts — COLUMBUS, OHIO

Founded 1927

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A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 7 **July, 1928** **No. 7**

EDITORIAL

THE PROBLEM OF PRINTED TABLEWARE[1]

BY MARION L. FOSDICK

One rather quiet way in which the Art Division of the AMERICAN CERAMIC SOCIETY is successfully moving is in bringing to its members a better understanding of difficult problems, which seem easy of solution. That they are not so easy to solve is the thing on which the interest of the Art Division members must be focused.

Both artists and manufacturers are under criticism for our American tableware. Trained artists are considered necessary in most of the foreign plants manufacturing tableware. Censure of domestic tableware is perhaps fair, but not always helpful because too often it is made by persons who do not understand the situation.

The potter calls attention to the splendid and daring work in design and color in books, advertising pages, textiles, and glass, and questions the lack of this type of work in tableware. It is keenly felt that American tableware should not need justification in the eyes of the public. People of discrimination say that it is typical of the United States to put forth a product that is excellent technically, but poor or uninteresting from an artistic view-point. If these people should visit tableware

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, ATLANTIC CITY, N. J., February, 1928. (Art Division).

factories they would realize the difficulties which have already been overcome but probably would fail to sense the invisible economic pressure which generally makes prohibitive the enlargement of a plant to include a designer or the delicate process required for making decalcomania. At decalcomania, even the potter, used to the delicacy of ceramic manipulation is amazed and in his surprise becomes at once tolerant of the situation.

To appreciate the problems involved in the production of decalcomania it is necessary to see the production done on a large scale. The intricacy on which success depends and the breadth of mind of the manufacturers in their attitude toward design, traditional and modern, and toward the development of quality in form and color are arresting and interesting. For their designs, in addition to their own designers, they are in consultation with outside designers and are trying out the market value of very modern and colorful patterns.

Making of Decalcomania

The making of decalcomania in general, and as carried on in one particular company is as follows:

Preparation of Stone The lithograph stone used for the print is a porous limestone found in Bavaria, valuable because it will absorb both oil and water though not both in the same place. The design is prepared and set on a stone with a crayon of waxy finish, and from this an impression is taken.

The print for each color is taken off on its own stone an equal number of times, the key-print giving the location of each color on the stone.

Hand Printing The stone is wet with water which is rejected by the waxy nature of the design. A special varnish is then applied with an ordinary printers' roller. The part of the stone which is wet with water rejects the varnish. The stone is then fanned dry and an impression is taken on a lithographic press. The varnish is thus transferred to paper.

The ceramic color is then dusted on and the print is passed on to receive the varnish from the next stone in the series making up one decalcomania print. In this manner one color is overlaid on another with accuracy and the color scheme is built up, which in transference to the ware is reversed, the last color printed being the first to touch the plate.

The process of making the stone and printing requires skilled workmen. In addition to skill, a knowledge of ceramic colors, side by side and superimposed, is required. Atmospheric changes of temperature and humidity vary the consistency of the varnish and the size of the

paper. Apparatus by which a room may be kept unvarying in temperature gives a fine solution to this problem, at an increased cost of upkeep.

Should Manufacturers Make Their Own

Considering the added overhead of skilled workmen and of perfection in control required by materials and surroundings it is obvious that few manufacturers can make their own decalcomania in spite of the fact that their individuality in designs and distinctive output would result in increased sales and profits.

The problem remains to find a solution to the situation for those manufacturers who do not make decalcomania.

Decalcomania is made in this country by at least two firms, although a larger part of our patterns comes from Germany or France. Patterns are sold in bulk to the various firms. How the designs are made for our own decalcomania firms is not known to the writer, but it seems that this is the point on which we should focus for an explanation of the timidity or sameness of many of our patterns. It is a problem of such importance that the manufacturers should be vitally interested in its solution.

Harmony in China Decoration

The charm of table decoration lies not only in its intrinsic beauty but in its interest relative to its surroundings. The linens for the table may be delightful in color and pattern but if they are not in harmony with the glass, silver, and china on the table, their intrinsic charm has little value for the occasion. A leading silver manufacturer is instructing employees and the public in making silver harmonious with various occasions, formal and informal, with lectures and exhibitions.

This may sound like a purely cultural project and not connected with economic or competitive problems, and yet it may be true that if the cause and effect between the criticism of American and the keen competition with foreign ware could be ascertained, a relationship would be found.

The beauty of our tableware relative to occasions and surroundings in which it is used is a technical problem of manufacture to be solved by study and practice. Results will show in an increased demand for domestic ware. The pleasure and spontaneity of design and color which artists often see in the saner European ware must come from logical discriminating persons who design or make them. This may not at present be a practical point of view except for our larger manufacturers who are leading the way. The idea perhaps forms a basis for discussion as to the better coöperation again between artist and manufacturer.

PAPERS AND DISCUSSIONS

TRENDS IN MANUFACTURING MANAGEMENT[1]

By Charles W. Lytle

Prosperity Following the First Industrial Revolution

A new country possessed of unlimited natural resources, and stocked with virile and inventive pioneers was bound to become prosperous. Much has been said about this prosperity but few have noted the change in trend and when it occurred. The old trend has been steadily but slowly upward since the so-called industrial revolution and was due mostly to the improvement in machinery. About 1904 a second upward trend appeared. Improvement in machinery has continued as before and always will, but it is a question whether or not the continuance of a single influence would account for the very definite change in the trend. Other major influences adequately account for much of the new trend and must be utilized as well as the further improvement of machinery.

Greater Prosperity Following the Second Industrial Revolution

To quote one current writer, R. G. Tugwell[2]

> whereas the first industrial revolution was brought about primarily through the invention of new machines, the second is mainly the result of the application of new processes and methods to the use of machines.

Dr. Tugwell further mentions the spread of standardization, the growth of the continuous process or production-chain serialization of machines, the development of larger industrial strategy including careful preplanning, better accounting, and budgetary control. It was also important that with the completion of railroad systems manufacturers became less and less local in their marketing. There is now a most unique situation in having over 110,000,000 people speaking a single language and following practically a single set of customs. It is this situation which permits mass production methods on a scale impossible to any other country. Enlightened management and mass production are therefore the factors which have given our prosperity curve an increased slope since 1904.

The following figures are used by courtesy of J. W. Roe.[3]

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J. February, 1928. (General Session.)

[2] R. G. Tugwell, Industry's Coming of Age.

[3] Sources: Statistical Abstract of U. S., N.I.C.B. Charts.

TABLE I

Years	Value added by mfg. in millions of dollars		No. wage earners in thousands		Value added per worker in dollars	
1849	464	÷	957	=	484	
1859	854		1311		650	
1869	1395		2054		676	
1879	1973		2733		722	
1889	4210		4252		990	
1899	5656		5306		1065	
1904	6294		5468		1150	Same corrected to 1914 purchasing power
1909	8529		6615		1290	
1914	9878		7036		1405	
1919	24748		8990		2760×58.1% = 1604	
1921	18272		6938		2640×61.3% = 1618	
1923	25777		8768		2940×61.8% = 1815	
1925	26778		8384		3200×59.3% = 1896	

See accompanying Fig. 1.

Mass Production Dependent on Coördination

Changes in our thinking come gradually and sometimes without realization. The mental change which preceded mass production was, however, fundamental and vital to its success. We had to learn how to coördinate component resources better than they had ever been coördinated before. This involved an entirely new attitude of mind which might be called scientific if that term were not so closely associated with the laboratory. As a matter of fact every work place can be a laboratory temporarily. Under mass production more and more skill is being transferred to machinery. Often numerous operations are performed simultaneously on a single machine. Sequential operations must be balanced and must be coördinated. Major branches such as production and marketing are in need of this coördination. Improved machines and operators can be idle if the management has not done good planning or if it can not carry through its plan. A product must not only be designed to function but it must be designed to facilitate processing. Management must therefore look into design. There is usually a "one best way" to do every process and to do every operation. Management must do process and operation analysis. Standardization of the product, the best equipment, and the best method will still be wasteful if labor does not coöperate intelligently. Management must therefore maintain satisfactory labor relations. As far as organization is concerned, management will have improved that long before these other achievements are accomplished, because they cannot be accomplished at all with some types of organization.

Study Essential In all this coördination we see the importance of study or research. The use of chemical research alone has revolutionized many a process as the ceramic industry knows and chemistry is only one of many fields of study affecting

industry. The practical man has sometimes belittled the knowledge in books and certainly many books exist without justification. But after all, the written document is our means of accumulating and transmitting knowledge. In this connection it is interesting to note that trade and professional literature has also had a growth quite parallel to that of production in general. A modern manager states that 90% of his job is to teach his subordinates, but how can he teach if someone has not provided him with recorded studies? The attitude of study is perhaps more important than a long experience in study. If any organization can be brought to this attitude, problems begin to work out and coöperation becomes a natural condition. Since the development of this condition is exactly what management is for, it is evident that the "study and teach" attitude has become almost the cornerstone of modern management.

Change from a Vicious to a Constructive Cycle

Up to the turn of the century, bookkeepers, money manipulators, and lawyers had doctored industry until systems and precedents had become almost sacred. The paper forms and clerical work in some cases nullified all the gain made in machinery. Employers figured on making enough extra profit during a boom year to carry them through the rest of the periodic business cycle. In the meantime the employees together with many middlemen experienced grave reduction in their purchasing power. This constituted a vicious economic cycle. To change it into a constructive cycle of more productivity, cheaper manufacturing cost, higher wages, greater purchasing power, bigger markets, lower prices, greater volume of sold production, simultaneously with a reduction of working hours and a restriction of immigration, took something more fundamental than "systematizing." But this new order is just what has been brought about in this country. It sets a severe pace. The employee gets a real task per hour and the employer gets a narrow margin of profit per unit. But many think that it is the better way. The uninterrupted working of this cycle is suggested as the best definition of prosperity.

Taylor the Great Pioneer

Every captain of industry, every railroad builder, and every trust has contributed individually in the shaping of the intricate fabric of production. Frederick W. Taylor, however, stands out in the work of building the industry of the country. He began in 1880 as a machinist's apprentice. One of his first contributions was a machine to grind

drills but this machine was contrived to get the one best shape for all drills used by workmen. It was this idea of finding a better method and of bringing that to all employees alike that characterized all of Taylor's career. He became foreman of the tool room, took engineering at night, and soon found himself a general foreman over machinists. He knew the work of the machinist from having been one and yet he found that as foreman he could not be sure of the best combination of speed, feed, depth of cut, etc., on any job he assigned. In fact there were even more variables, twelve in all, for every machine-tool job. There was no reliable information on these combinations and almost a limitless number of them. He secured permission from William Sellers of the Midvale Steel Company, to experiment on the turning of car wheels. He would hold eleven of the variables constant while he varied the remaining one, etc., always keeping records and noting everything which might bear on the problem. Results began to come at once so that the costs of experimenting were more than met from the beginning.

Taylor's Machine Shop Developments

To illustrate Taylor's procedure some of his first discoveries are given here. He made these public in 1906.

(1) A round-nosed tool can be run under given conditions at a higher speed than the old diamond pointed tool.

(2) Coarse feeds accompanied by slow speeds will do more work than fine feeds and high speeds.

(3) A heavy stream of soap water poured on the point of greatest friction will permit an increase in speed and therefore the amount of work to the extent of 30%.

(4) The development of formulas which gives mathematical expression to the above laws.

(5) Belts should be accurately calculated and their correct tension constantly maintained.

(6) The power to feed a tool ahead is as much as the power to drive the cut.

(7) Tool grinding, storing, and issuing can be greatly improved.

(8) An entirely new process of heat-treating tools made from chromium-tungsten steels will make possible from 2 to 4 times as much work.[4]

(9) The development of slide rules will solve the 12 variables.

(10) The addition of vanadium to the above tool steel gives further improvement.

Taylor's General Developments

While Taylor's first discoveries were in the narrow machine shop field, they made it possible for him to set definite tasks and to draw

[4] This refers to the Taylor-White high-speed tools which actually revolutionized all machine shop practice including the design of machine tools.

tighter the responsibility of both employee and employer. From this point on, his developments were applicable to the general field of manufacturing. From his old geometry teacher, G. A. Wentworth, of Phillips Exeter Academy, he had learned the idea of timing human work with a stop-watch. He made a serious mistake in attempting to conceal his stop-watch from the men being studied but later repudiated such tactics. Taylor never did handle employees tactfully and for that reason much opposition developed at first on the part of organized labor. His experiences with "high class" pig iron carriers, etc., became famous, "now carry, now rest, now carry, now rest." Here we have a definite recognition of the desirability of rest periods at stated times to prevent the accumulation of over-fatigue. His differential bonus principle for rewarding task employees also had wide influence. Along with the above experiments Taylor developed the centralized planning idea together with a new type of functionalized organization. While much modified, both of these principles are in wide use today. Other known principles such as conservation of skill and the "exception" principle were recognized and given new emphasis. H. L. Gantt and F. B. Gilbreth, the two main successors to Taylor benefited by his mistakes and went far beyond him in many important respects. Nevertheless, the pioneer work of Taylor between 1880 and 1906 proved definitely the value of studying shop conditions.[5]

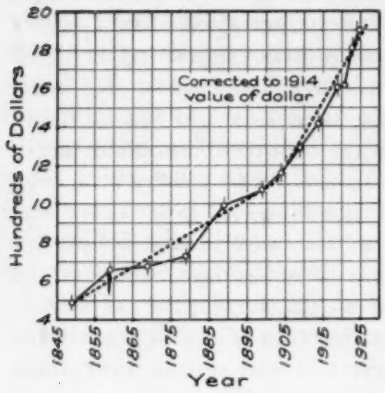

FIG. 1.

Gantt Humanized Taylorism

Henry L. Gantt changed the wage plan to make it less severe although retaining the essential effect of high production rewarded with high wages. He introduced man-record charts which added a nonfinancial incentive and out of which eventually developed the so-called Gantt Chart. This is one of the most important charting mechanisms ever invented. It brings the preplanned schedule and the actual performance close together on a single line opposite an individual man or machine and allows a comparison of many individuals at a glance. It is also

[5] Taylor, On the Art of Cutting Metals (1906), Shop Management, Principles of Scientific Management; Copley, Fred W. Taylor (2 vols.)

simple to keep up. There are many special uses of this chart.[6] His ideas on the importance of correct work habits will be found in his first book.[7]

Perhaps Gantt's greatest achievement was in convincing employers of their responsibility for training employees to do the high tasks prerequisite to earning bonus. Gantt studied the stores problem. Here he developed the principles in use today, particularly the "order point" which has helped purchasing agents keep down the money invested in stock. From material control he went into the routing, scheduling, and planning of goods in process. His most quoted saying is,

> two-thirds of all gain possible through the most efficient management could be realized by having all the material ready when you want it, where you want it, and in the condition you want it.

This is practically a definition of modern production control. This in turn led to better plant maintenance on one side and to tighter inspection of quality on the other. He later modified Taylor's centralized planning so that all foremen could contribute and feel that the plan was of their making. This, of course, helped greatly in getting it carried out. As a leader of men he was Taylor's superior.[8]

Gilbreth Refined Job Standardization

Frank B. Gilbreth, a construction engineer, became interested in Taylor's ideas and pointed out that timing operations had little permanent value unless adequate records of motions and conditions could be made. He began studying the motions of brick layers and soon demonstrated that a man's output could be tripled, production costs lowered, and wages increased simultaneously.[9] From the beginning he showed an appreciation of skill, automaticity, rhythm, etc., which Taylor had not possessed. He consequently developed every law of motion which we have. He also deserves credit for much of our interest in the study of fatigue. As the motion camera was the only means of recording minute changes of motion and attitude, he went into that kind of study. A fast moving clock was always placed in the picture so that each picture was marked in its successive time. The analysis of these motions and times by means of the "simultaneous motion cycle chart" and the standardization of the best synthesized set of motions by means of a wire model "cyclograph" is an interesting but technical story.[10] It allowed him to study experts and champions

[6] Wallace Clark, Gantt Charts.
[7] H. L. Gantt, Work Wages and Profits.
[8] *Ibid.*, (1) Industrial Leadership, (2) Organization for Work.
[9] F. B. Gilbreth, Motion Study.
[10] *Ibid.*, Applied Motion Study.

and to capture the very best motions to teach others. He called it "motion study" to distinguish it from the "time study" of Taylor and his stop-watch followers. As the best stop-watch practice today takes some consideration of motions also, Gilbreth's method has come to be known as micromotion. Either method is correctly called "job standardization." Gilbreth's work led to a more scientific arrangement of work benches, and to "prepositioning" of tools and assembly parts. This kind of study not only eliminated wasteful and fatiguing practices, but frequently led to better material handling such as overhead monorails and special lifting devices. Either type of job study tends to extend the use of special tools, jigs, and fixtures. This has spread to every kind of industry.

Emerson's Principles of Efficiency

On the popular side Harrington Emerson was pointing out the millions of dollars wasted daily in railroad operation. He also published in 1910 his "Twelve Principles of Efficiency" which gave coin to that first popular and then unpopular term. It was a day of big fees for consultants and many early consultants were little more than irresponsible exploiters. Despite the bad record of many "efficiency experts" the principles of Taylor and of Emerson have survived and are being incorporated everywhere but often by staff men rather than by consultants. Consulting is tending to shrink back to a few very experienced men where it belongs.

Emergence of Correct and Prompt Cost Finding

To keep pace with this era of fact finding, the cost accountants, at one time content with post mortem figures, began to develop real cost finding. That is the presentation of cost figures promptly enough to indicate where losses have just occurred. They followed the task idea and now under the name of standard costs, can give a foreman standards of cost above which no item should go. The break down into costs of every operation has lessened "cut-throat" competition and is a first essential of any modern management. Some of them, however, have far to go yet in the matter of distributing burden so as to take proper care of idle equipment, obsolescence, etc. Budgetary control as a matter of financial preplanning is a matter familiar to all. Its almost universal use is most creditable to administrative officers.

Personnel

On the labor side, increased size of industrial units lead to the functionalization of all personnel duties. Like the efficiency expert the employment manager or personnel director went beyond his limits

especially during the war period when employers were ready to try anything. This function has readjusted itself, however, and is now rendering a great service in steadying employment and adjusting employee demands. Guaranteed rates have usually followed carefully set tasks so that with the present shorter work day there is increasing promise of full employee coöperation. Works councils and other forms of so-called "industrial democracy" are making headway. The essentials of this, however, can often be secured through some kind of foremen's conference rather than through the elaborate and extreme forms sometimes tried.

Statistics, Graphics, and Economics

Bureaus of statistical research both governmental and private are doing much to forecast business conditions. With this fairly reliable information, many employers are now leveling the worst peaks and valleys of business so that labor turnover and unemployment is less extreme in its variation. Periodic business cycles may occur but with the Federal Reserve Banking System and with the use of knowledge now available, they are not likely to be as severe as formerly. We are ceasing to fear economics and beginning to use it. The following questions are of economic importance.

(1) What is the most economic size for a manufacturing lot?
(2) How much money will a given quantity of production allow us to spend for improved equipment?
(3) What is the economic purchase quantity of a given raw product?
(4) What is the best percentage of seconds to allow?
(5) In a continuous process, what is the minimum unit cost?

These questions have always been guessed at or estimated from previous experience but now we are approaching them as economists. The first three of these have already been reduced to mathematical formula. This practice will seem too theoretical to many but it is getting the serious attention of many practical employers. They conclude that formulas can be determined which will allow for the main variables and that they should be used at least as foundations.

The Standard Product

The principle of specialization has penetrated through individuals, through machines and tools, through the organization and now is appearing in products and in whole plants. It may seem that it is all right for a large company like the Ford Motor Company to narrow down on its product but that a small company must cater to customers by offering any style, size, or variety requested. As long as close competitors are doing this, it is difficult, but fortunately a governmental

bureau, that of Simplified Practice, Department of Commerce, has been most helpful in bringing together such competitors. Through the offices of this Bureau nonprofitable lines have been eliminated in every conceivable field. Some ceramic industries have been among the foremost. Certainly we are not in manufacturing to sell at a loss and transferring the loss or near loss to other more profitable lines is at best dangerous. Here again a correct cost system is of great assistance. When the real cost of some lines is known there will be much more of this simplification. Present day interchangeability requires a well thought out standard design and standardization should be preceded by a strict specialization of product.

Marketing Loss Satisfactorily Solved

On the marketing side the idea of following lower costs promptly with lower prices in order to stimulate buying has contributed most to the constructive cycle. Ford certainly deserves credit for his courageous example in this. The study of capacities and inclinations of buyers in all sections, the establishment of sales quotas, which are tasks set by statistical estimate, the determination of the best mediums of advertising, generally to help intensify rather than to extend sales activity; these are now being treated as a distinct function called merchandising. It assists the sales department in educating buyers and even assists the jobber or retailer in educating his buyers. Unfortunately some men in this field seem to get panicky under keen competition and resort to a type of high pressure sales which is reckless in its expenditure and in its ethics. In fact it is conceded on all sides that distribution as a whole is still most inefficient. Some ask why they should save pennies in production when others are throwing away dollars in getting the product to consumers. Under the "new competition," which is an intensely severe and complex competition, this is becoming the most serious of all industrial problems and one of the most elusive in its nature. It can hardly be solved in a laboratory and the coöperation needed is to some unthinkable.

Research

Some groups prefer to do without basic research for fear competitors may learn their secrets. There is more to be gained in pooling resources for basic research than in standing jealously apart. The very largest companies in this country are today most generous in research coöperation. Their exchange of findings, their mutual assistance, is one of the most encouraging facts of the times. Several companies spend over one million dollars annually for research. Of more importance is the fact that thousands of small companies are deriving the benefits

of research through such media as the Mellon Institute or through a body created by their own coöperation. Of the latter type the American Petroleum Institute has over 3500 individual members and its work has included economic, technical, and scientific researches. It has a division to standardize the best oil-field equipment and the result is that American oil-field supplies are standard the world over. Similarly the Copper and Brass Research Association has become a strong organization and claims to have doubled the consumption of copper during the past five years. The American Gas Association has an extensive program. The ceramic industries also should coördinate all the resources which a most scientific age is presenting.

Science in Management

Of course good management always has and always will include a certain amount of instinct, skill, and leadership which cannot rightly be termed scientific. It is correctly claimed therefore, that modern management is partly art and never will be entirely a science. At the same time the so-called "scientific method" has penetrated management as it has penetrated everything else. So much is this true that the college graduate is getting into management more and more despite some very definite handicaps. For instance, most of the engineers are trained in some special technical field such as mechanical engineering, electrical engineering, etc., not in management or even in manufacturing methods. Statistics covering some 55,000 engineering graduates prove that two-thirds of those who have been out of college fifteen years or more hold executive positions and only one-third hold strictly technical positions. It is true that most of these men started in technical positions but soon gave them over to younger recruits and went on into managerial work. This shows that training in applied science is becoming more important as a qualification for management. Furthermore, the noncollege man is taking night school courses as never before because he knows that without some training in applied science he will be greatly handicapped in competing for promotion. Every line of manufacturing now includes some scientific processes and in direct proportion as management is becoming less a matter of guesswork, it is becoming more coöperative and vice versa.

Summary of Modern Management Mechanisms

Besides the coördinating function of higher administration, there are at least twelve major "mechanisms of management" which are in use in our most successful plants and which are essential to carry out the principles already cited:

(1) Budgetary control: permits the preplanning of financial allocation and is vital to the realization of right profits.

(2) Market analysis: balances sales possibilities with production capacities and regulates production schedules together with employment.

(3) Quality control: sets product standards and enforces them so that deficiencies are caught before running into much money; it also draws up specifications for purchasing materials.

(4) Stores control: decreases inventory, increases the rate of material turnover, and prevents delays.

(5) Maintenance of plant and equipment: prevents delays and unnecessary depreciation.

(6) Process and operation analysis (job standardization): determines the best equipment, routing, tools, and methods; sets proper tasks and rates, giving a fair and enduring basis for wages.

(7) Planning and scheduling: obviates idleness of men and machines and makes possible the keeping of delivery promises.

(8) Production control: carrying out of work according to No. 7, and is said to result in from 85 to 90% of the expectations.

(9) Incentives: provides for financial and nonfinancial stimulation, also for promotion; it reduces labor cost of production and steadies as well as increases the amount of production.

(10) Labor control: secures the proper individual for each job and promotes dependable employee coöperation.

(11) Standard costs: permits the setting of profitable selling prices and assists in showing up many wastes.

(12) Research and design: furnishes basic facts, eliminates guesswork, and keeps executives abreast of important developments outside of their own plant.

NOTE: Besides the foregoing references, the following are the best to give a thorough understanding of what the analytical method has accomplished in management.

Management's Handbook, (30 authorities), Ronald Press, 15 E. 26th St., New York City. L. P. Alford, Laws of Management, A.S.M.E., 29 W. 39th St., New York City.

For current literature see footnotes to C. W. Lytle, "Progress in Management Engineering," *Mech. Eng.*, Jan. 1928.

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MODERN TREND OF DESIGN FOR POTTERY PLANTS[1]

BY H. S. JACOBY

ABSTRACT

A discussion of the most advantageous type of building to house pottery manufacture is given. The one-story building is advocated in preference to a multi-story building. Objections raised to one-story construction are cited, but overshadowing advantages are enumerated. Details recommended by best modern practice in the construction of one-story plants are given.

Introduction

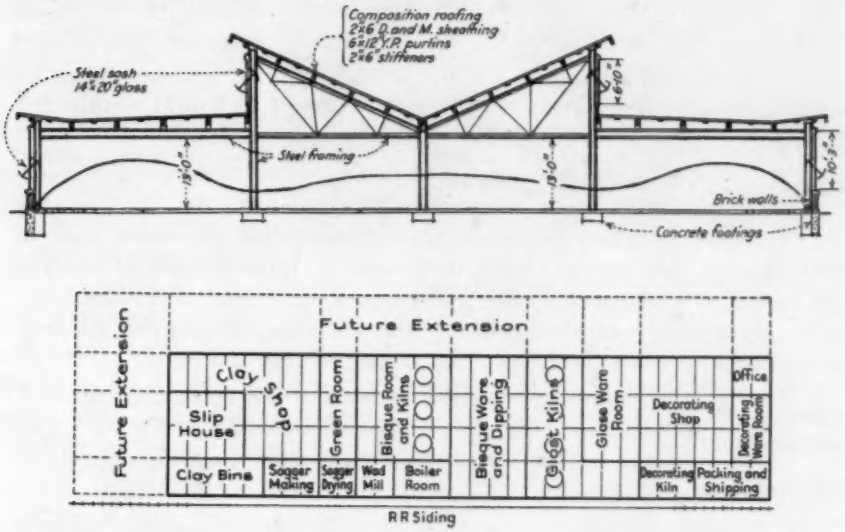
In the manufacture of pottery, there are several mechanical features that enter into the problem of continuous production, such as tunnel

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City N. J., February, 1928. (White Wares Division)

kilns, mechanical driers, and overhead conveyers. The problem to be considered here is the most advantageous type of building to house pottery manufacture.

One-Floor vs. Multiple-Floor Building

Fundamentally the outdoors without any enclosure would furnish the ideal situation for a pottery plant if it were not for weather conditions. Problems of expansion, lighting, ventilation, entrance and exit would be simple and no walls or posts would be in the way.



FIGS. 1*a* and 1*b*.—Typical plan and cross-section of periodic kiln plant showing provision for future extension. Contour line indicates distribution of natural lighting.

The practical step is to so house the industry that there is good ventilation and plenty of light; so that the location of columns and walls is not objectionable and expansion is readily possible in any direction. In other words, the plant should be so designed that the presence of the building in no way handicaps the industry which it houses. Manufacturing plants are coming today to be thought of less as buildings and more as integral parts of production equipment.

There are many industries today operating in multi-story buildings. In some cases the nature of the business is such that production can be handled economically, but there are many cases where all arguments except the cost of land are in favor of one-story construction. This is expecially true in the pottery industry, where heavy materials must

be handled with utmost economy and speed, and where equipment is large and very heavy.

A few years ago the National Cash Register Company's plant at Dayton, Ohio, consisted almost entirely of multi-story buildings. John Paterson, then president, ordered two large single-story buildings. After seeing the results of ground floor operation with increased economy and speed, he declared that he would use only the single story construction if he could obtain the land.

FIG. 2.—Illustrating the pleasing effect obtained at small cost by use of stone coping and face brick on street side.

Objections to One Story

In addition to the difficulty of securing ground space two other objections to one-story construction are sometimes raised: (1) the possible increased cost of maintenance due to the larger roof area; (2) greater cost of heating because of greater roof area and glass exposure. These objections, however, are greatly overshadowed by the advantages obtained through single-story construction, especially in the pottery industry.

Advantages of One Story

(1) Abundant natural ventilation can be secured through the roof as well as through side-wall sash. No such roof ventilation is possible in multi-story buildings except on the top floor.

(2) Natural illumination from the side walls is augmented by light through the sash in roof monitors, saw-teeth, or sky-lights, giving uniform lighting over the entire floor area. The light does not die out near the center of the building, and shadows are reduced to a minimum regardless of the width of the building. On the contrary, a multi-story building can never exceed 80 feet in width if fair illumination of the interior is required; sixty feet is better. We have recently built two large multi-story buildings for a prominent shoe manufacturer with a width of 45 feet. This width affords abundant light for the close operations in connection with his production.

(3) Since the roof load is light compared with the floor loads required in a pottery plant, the aisles in a single story building can be from 30 to 50 feet, and still be on the same basis of economical design as a multiple-story building with 16 to 20 feet column centers. This means minimum interference by posts.

(4) In a one-story building, the heavy loads are carried on the ground. Heavy machinery can be located to advantage on concrete foundations without regard to its weight. In order that additional floors above may easily carry this heavy machinery, the entire floor on which it is located must be designed to carry the heavy load.

(5) Since in one-story buildings, stair wells and elevator shafts are not needed, a saving of at least 5% in floor space is possible. Time and money are also saved in moving employees and freight.

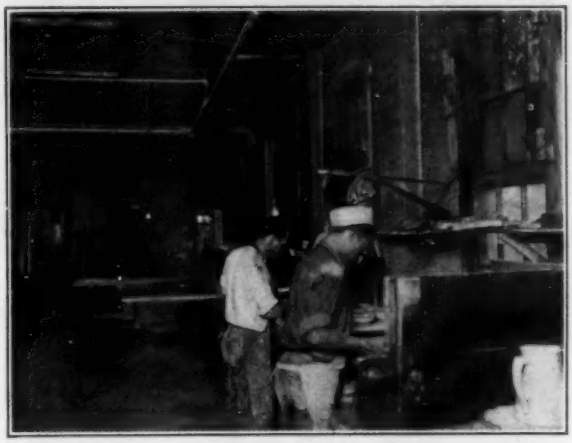


FIG. 3.—Dark working conditions cause eye strain and poor ware.

(6) Expansion in any direction is possible, and the shifting of departments may be achieved on an economical basis.

(7) Pipes and ducts for heating, ventilation, etc., may be run overhead in the roof trusses without encroaching on the clear headroom below the lower chord of the trusses.

(8) Continuous straight-line production is possible, and careful supervision is easily maintained over the entire plant from the raw material at one end to the finished ware at the other, as there is no interference in the line of vision.

(9) From a purely business standpoint, the one-story building is a better asset in most cases than a multi-story building, because it is suited to a wider variety of uses and is therefore more easily salable. It is a bankable asset because of its universality.

Modern Construction of One-Story Plants

Fire-proofing Structural steel framework and steel sash, while they are noncombustible, are not fire proof. The 2-inch wood roof supported by heavy timber beams is slow burning. A building of this type must be protected with an automatic sprinkler system. The initial cost of a sprinkler system with an elevated tank is a large item. On the other hand, the saving in the insurance rate is considerable, and

the insurance companies have worked out a method of paying for the system from the savings in premium. This spreads the cost out in moderate payments over a long period. A sprinkled pottery building including contents may carry a rate of 10 cents per $100.00 per year, while an unsprinkled building with a wood roof takes a rate of 65 cents. The rate on the same building with a concrete roof unsprinkled is 35 cents. Little benefit accrues through the use of a concrete roof if sprinklers are installed. The insurance rate can be further reduced by attention to such items of hazard as the location of the packing room, kilns, or boiler room, the use of fire walls, the presence of hydrants, inside hose connections and watchmen.

FIGS. 4 AND 5.—As compared to daylight conditions where jiggers and molders are shown.

Window Lighting The modern pottery plant no longer has double hung wood windows with brick walls between them. By the use of continuous steel sash in modern plants, we now have a 100% illumination above the sill height instead of 50% obtained in the older type of construction. The wood sash has a tendency to warp, and is more expensive to maintain. On account of the wider frame and mullion, it is considerably less effective as a medium of light. Glass sizes which were formerly 10 by 12 inches have been increased to 14 by 20 inches. The actual cost of wood sash glazed and installed is 50% more than that of steel sash.

Substantial brick walls to window-sill height are recommended for permanent construction. The cost of this item is relatively small. It is good business to spend a little more money on the appearance of the street side of the building. This may be done by using face brick or common brick selected for color with a moderate use of stone or

terra cotta trim. If the cost of face brick is excessive, a pleasing result can be obtained by using seconds with slightly chipped corners or mottled colors. Once in the wall, these defects are scarcely noticed and the total effect is very pleasing. A building should not only be structurally right but it should look right. Therefore, the special attention given to the exterior of the permanent street wall in the way of artistic treatment is money well spent and adds appreciably to the intrinsic value of the plant.

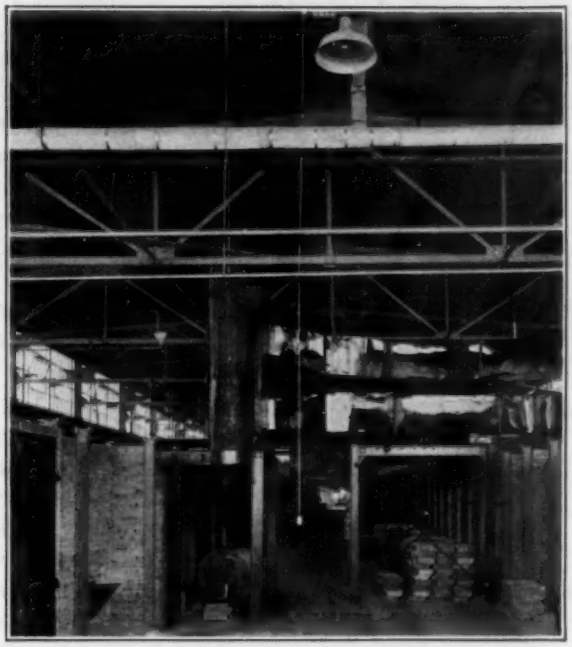


FIG. 6.—High aisle construction with plenty of ventilation over continuous kilns.

In general the roof construction for a one-story plant should include a structural steel frame, designed not only to carry safely the snow, wind, and dead load, but also to accommodate monorail and shafting loads, unit heaters, or other equipment which might be added later on.

Usually a flat roof near the outer walls with saw-tooth construction over the main area and a raised monitor portion over the continuous kiln will give an ideal layout for light, ventilation, and economy.

Considerable research work has been undertaken recently so that we are now able to plot a curve which indicates in advance the intensity of light at any point in the building. The quantity of dirt, however, which some plants allow to accumulate on the exterior surface of glass will in six months' time reduce the effective illumination as much as one-half. Expensive as it is to secure good light originally, the economic advantage in keeping the windows clean is becoming more and more appreciated.

Paint is another item which is receiving considerable attention because of its bearing on illumination. The dead black formerly used on steel work is being supplanted by light gray or white. Walls and

ceilings painted white reflect light to a marked degree, particularly from the underside of sloping roofs. Here again cleanliness is imperative.

Among other things our research work has disclosed this interesting fact. Mill white paint with a flat finish is less subject to the accumulation of dirt than a gloss finish. This is hardly in keeping with usual experience in ceramic materials, but it must be remembered that the gloss in paint is almost entirely dependent upon the amount of oil present and although apparently dry and hard, this gloss surface has a sticky consistency which catches and holds dirt. On the other hand, the flat finish is dry and to some extent powdery and offers less attraction for dust particles.

The best location for the office in a plant is in one corner of the factory building. The office is in one sense unproductive floor space, and a separate building is not only a considerable fixed expense, but lessens the opportunity for close inspection of the factory. Movable steel partitions with glass or solid panels can be set up at small expense, and moved to another location in case re-arrangement of departments demands a change. When the plant has grown to considerable size, it is well to think of a separate office or administration building.

Just a few features of construction have been touched upon; materials recommended which are produced, assembled, and erected by the same straight-line methods which are advocated for other industries; structural steel, consisting of beams and trusses by continuous process on multiple punches; lumber of very few sizes, all commercially available; sash which is rolled and pressed by the mile, and glass in one size.

THE H. K. FERGUSON CO.
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A SYSTEM OF COLLEGE EDUCATION IN CERAMIC TECHNOLOGY[1]

The Problem

During the past few months the members of the Committee on Education have made an investigation into the field of higher education. The work was begun rather nonchalantly, because the assigned task of finding a course of education for the training of enamel technologists seemed to be an easy and pleasant one. With study, the problem grew more difficult, but a proposed course of college training for enamel technologists now can be recommended which the Committee, at least, thinks is a fairly satisfactory one. The two problems now confronting the Committee are (1) to prove the value of this course of instruction and (2) to persuade some college or colleges to give the course.

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[1] Report of the Committee on Education, Enamel Division, AMERICAN CERAMIC SOCIETY. Presented at Annual Meeting, Atlantic City, N. J., February, 1928.

Education for the Enameling Industry

When the Committee first met there was little difficulty in arriving at a general agreement as to the kind of education that is desirable for young men about to enter the enameling industry. It was agreed that the enameling industry does not desire men who are trained as enamel chemists only and who can be expected to become simply enamel mixers. A man who is only an enamel chemist or enamel mixer is not very valuable to an enameling firm since his range of usefulness is limited. Therefore, he is often quite a disappointment to the firm who hires him with the idea, that, being a college trained man, he will be able to solve all their technical difficulties and be a major factor in helping the firm to produce large quantities of fine enameled ware at the lowest possible price. The obvious reason for this is that the production of large quantities of fine enameled ware with low losses and low costs is only in a small part dependent on the enamel mixture and is very largely dependent on the quality of the cast iron or steel used in making the shapes to be enameled, the manner in which these are made, the care used in preparing them for enameling and the skill and judgment used in applying and firing the enamel.

These larger factors involve a knowledge of (1) metallurgy, (2) foundry practice or of steel working, and (3) an understanding of the great importance of the human element in manufacture, *i.e.*, the problem of obtaining loyal and efficient service from the rather nondescript mass of laborers usually found in an enameling plant. These factors are things beyond the vision of the average young chemist.

This Committee does not feel that all of these can be taught in colleges, but they do think that a college course can be so devised that a young chemist will have some comprehension of their significance and, when he is once working in an enameling plant, will readily learn to make himself useful, not only in analyzing raw materials and in mixing enamels, but also in the general operation of the plant.

On the other hand, the young chemist, or old chemist for that matter, who is simply a chemist and an enamel mixer, is invariably inclined to magnify the importance of his own office and to think and say that all the difficulties of the plant are due to the ignorance or mistakes of others. Since he feels that his own work is so vital to the plant and since the management realizes that his services are of limited value and consequently object to paying him a large salary, the chemist is very liable to be dissatisfied.

The Committee decided that both for the sake of the industry and for the sake of young college men entering the industry, the ideal college course would be one which would so train a man that he could enter an enameling plant as a chemist and laboratory worker. At the same time, it should prepare him to progress with fair rapidity through the positions of enamel mixer and foreman to that of assistant superintendent. Finally, it should be so broad that, provided that he demonstrates in these positions the possession of some brains, adaptability and energy, he can look forward to becoming plant superintendent, plant manager, and possibly plant owner. In other words, the ideal college course is one which, insofar as it is possible to do such a thing in a college, would give a man a fundamental education. This, together with a certain amount of native ability and a large amount of practical experience, would enable him to become an efficient plant executive or to occupy even higher positions in the industry.

Fundamental Requirements

Little difficulty was experienced in arriving at an enumeration of the technical studies the student should pursue. Mathematics, chemistry, metallurgy, physics, some mechanical engineering, and some ceramic and enamel technology were readily decided upon. Dealing with the business and shop management side of manufacturing, subjects such as economics, business law, labor problems, personnel administration and industrial management were enumerated.

After careful consideration of the individual cases of young men who have made rapid progress in the enameling industry and of the type of older men who are successful executives, the Committee came to a conclusion which may be surprising to some: If a man expects to achieve one of the higher executive positions in the enameling industry, he must acquire culture in college or outside of college. It is noteworthy that young college graduates who have progressed rapidly in the ceramic industries have been those with the cultural advantages of being able to write well and to talk well not only on technical subjects but on a variety of subjects. Cultural studies seem to make these young men more versatile minded, give them poise under difficult conditions, and to enable them to meet all sorts of people with equanimity.

A knowledge of chemistry will obtain a position for a young graduate in an enameling plant, but in later years, ability to gain the friendship and coöperation of a Hungarian laborer or a bank director will go farther in helping him to become president of his own company. It was decided, therefore, that whatever other studies this ideal college course contains, it must contain an irreducible minimum of cultural subjects.

Making the Plan Practical

This is the general outline of the ideal curriculum: scientific and technical courses, business and administrative subjects, and a certain amount of cultural studies. It would have been easy to have stopped at this point and to have made this recommendation of generalities to the Enamel Division and through them to the various college faculties. In this practical world, however, no one seems to pay very much attention to generalities no matter how admirable they may be. It was decided, therefore, to work out typical courses embodying these ideas by choosing subjects from the catalogues of two representative schools having courses in ceramic engineering, the Ohio State University and the University of Illinois.

By culling through the catalogues of these Universities, including the subjects taught both in the engineering colleges and the arts colleges, a great number of courses which seemed desirable to include in the curriculum were found. In fact, the number of desirable courses was about twice that possible to include in a four-year course. By weighing the merits of one course against others, the number was reduced somewhere near what could be included in a college course of normal length. When it came to making an actual curriculum, an intricate jigsaw puzzle remained to be solved.

In order to obtain certain desirable courses it was necessary to include in the curriculum other prerequisite courses that had not been listed. Some courses are given in all terms of the college year and others in only one. Each course, moreover, is assigned a certain number of credit hours and the total number of credit hours in the curriculum for one term must not vary more than one unit from the average. Taking all these factors in consideration it was quite a problem to work out a curriculum which would meet all of these conditions and be satisfactory to the Committee but finally a course for enamel technologists in each of these colleges was evolved.

Further Problems Involved

Then the question arose as to how to get either of these colleges or any other college to give such a course. The number of men desiring training as enamel technologists is comparatively small and it would be useless to expect any school to institute a separate curriculum for a few students. On the other hand, this curriculum was so radically different from that ordinarily given in ceramic schools, which cater particularly to the clay products industries, that it would have been impossible to embody the essential features of this course in enamel technology in these clay products curricula.

In reading through the literature on ceramic education, two articles were found that were helpful in this dilemma. One of these was a proposal by Dr. Silverman, Chairman of the Committee on Education of the Glass Division of the AMERICAN CERAMIC

SOCIETY, giving suggestions for a course of study for glass industry chemists and stating that his Committee was in the same position as that of the Enamel Division Committee, in that they were without hope of having any college give such a course. The other was a suggestion by Mr. Purdy that ceramic students take a uniform course for the first three years of their college work and specialize in studies relating to specific branches of the ceramic industry in the fourth year of their work. With these suggestions and after laboring with the practical considerations of time, place, and credit-hour limitations of the college catalogues, a proposal was evolved for a comprehensive system of education in ceramic technology.

Proposed Plan

In brief this comprises college courses in which the first year's work will be uniform with that of all other courses of engineering taught in the college. The second year's work will be uniform for all students in ceramic technology. The third and fourth years' work will have certain subjects which are taken in common by all students but other subjects which are taken only by students expecting to enter the clay products industry, subjects which are taken by students expecting to enter the enamel industry and subjects which are taken by students expecting to enter the glass industry.

Owing to the fact that certain elementary courses are prerequisite to more advanced courses in these specialized studies, it is found necessary that the student start his specialization in the junior year of college rather than in the fourth year. Thus all students in ceramic technology will take the first two years in common. By the beginning of the third year it will be necessary for them to choose a certain option, either the clay products option, the enamel option, or the glass option. The curricula and options are shown in detail by the accompanying charts. The special studies differentiating the various options are marked by asterisks.

OHIO STATE UNIVERSITY

First Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Mathematics Plane Trigonometry	(431)	5	Mathematics College Algebra	(432)	5	Mathematics Analytic Geometry	(433)	5
Chemistry Elementary or General	(401 or 411)	5	Chemistry Elementary or General	(402 or 412)	5	Chemistry Qualitative Analysis	(403 or 413)	5
Engr. Drawing Principles of Engineering Drawing	(401)	4	Engr. Drawing Principles of Engineering Drawing	(402)	4	Engr. Drawing Descriptive Geometry	(403)	4
English	(410)	3	English	(411)	3	English	(412)	3
Survey of Engineering Elements of Engineering		1	Survey of Engineering Elements of Engineering		1	Survey of Engineering Elements of Engineering		1
Military Science		1	Military Science		1	Military Science		1
Physical Education	(401)	1	Physical Education	(402)	1	Physical Education	(403)	1
Hygiene	(400)	1						
		21			20			20

Summer Quarter; Industrial Experience

Second Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Mathematics Calculus	(441)	5	Mathematics Calculus	(442)	5	Mathematics Calculus	(443)	5
Physics Mechanics	(431)	5	Physics Heat, Sound and Light	(432)	5	Physics Electricity and Magnetism	(433)	5
Metallurgy Metallurgical Analysis	(451)	3	Metallurgy Ceramic Analysis	(452)	4	Metallurgy Ceramic Analysis	(453)	4
Geology Physical Geology	(435)	5	Ceramic Engr. Occurrence and Properties of Clays	(401)	4	English Advanced for Engineers	(419)	3
Military Science		1	Military Science		1	Military Science		1
		19			19			18

Summer Quarter; Industrial Experience

CLAY PRODUCTS OPTION

Third Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Metallurgy Fuels	(651)	3	Mechanics Statics	(601)	5	Mechanics Strength of Materials	(602)	5
Chemistry Physical Chemistry	(680)	3	Chemistry Colloid Chemistry	(695)	3	Mineralogy Thermochemical Mineralogy	(605)	4
World Literature		3				World Literature		3
Fine Arts	(476)	1	Fine Arts	(477)	1	Fine Arts	(478)	1
Ceramic Engineering Ceramic Calculations	(615)	5	*Ceramic Engineering Drying and Firing	(601)	5	*Ceramic Engineering Lab. Work in Heavy Clay Wares	(701)	5
*Ceramic Engineering Winning and Forming	(405)	4	Ceramic Engineering Bodies, Glazes, and Colors	(605)	4	Ceramic Engineering Inspection Trip	(630)	0
		19			18			18

CLAY PRODUCTS OPTION

Fourth Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Economics Principles of Economics for Engineers	(403)	3	Economics Principles of Economics for Engineers	(403)	3	Economics Labor Problems or	(410)	3
Accounting Outline of Accounting or	(405)	5	Bus. Organization Business Law; Contracts	(621)	3	Bus. Organization Ind. Organization and Management	(681)	3
Public Speaking Principles	(401)	5	Mineralogy Advanced Thermochemical	(606)	3	Journalism Trade and Technical Journalism	(413)	3
World Literature		3				World Literature		3
Arts Survey Courses Development of Modern Civilization	(605)	3	Arts Survey Courses Development of Modern Civilization	(606)	3	Ceramic Engineering Refractories and Furnaces	(610)	5
Physics Molecular Physics and Heat	(609)	4	*Ceramic Engineering Thesis	(710)	2	*Ceramic Engineering Thesis	(711)	4
			*Ceramic Engineering Lab. work in Fine Ceramics	(702)	5	Ceramic Engineering Inspection Trip	(730)	0
		18			19			18

ENAMEL OPTION

Third Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Physics Molecular Physics and Heat	(609)	4	Mechanics Statics	(601)	5	Mechanics Strength of Materials	(602)	5
Chemistry Physical Chemistry	(680)	3	Chemistry Colloid Chemistry	(695)	3	Mineralogy Thermochemical Mineralogy	(605)	4
World Literature		3	*Industrial Engineering Foundry Practice	(405)	3	*Industrial Engineering Advanced Foundry Practice	(406)	2
Fine Arts Appr. of Plastic Arts	(476)	1	Fine Arts Appr. of Pictorial Arts	(477)	1	Fine Arts Appr. of Popular Arts	(478)	1
Metallurgy Fuels	(651)	3	*Metallurgy Iron and Steel Met.	(605)	3	Ceramic Engineering Refractories and Furnaces	(610)	5
Ceramic Engineering Ceramic Calculations	(615)	5	Ceramic Engineering Bodies, Glazes, and Colors	(605)	4	*Metallurgy Inspection Trip	(645)	0
		19			19			17

Enamel Option

Fourth Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Economics Principles of Economics for Engineers	(403)	3	Economics Principles of Economics for Engineers	(403)	3	Economics Labor Problems or	(410)	
Accounting Outline of Accounting or	(405)	5	Bus. Organization Business Law; Contracts	(621)	3	Bus. Organization Ind. Organization and Management	(681)	3
Public Speaking Principles	(401)	5	Mineralogy Advanced Thermochemical	(606)	3	Journalism Trade and Technical Journalism	(413)	3
World Literature		3	World Literature		3	World Literature		3
Arts Survey Courses Development of Modern Civilization	(605)	3	Arts Survey Courses Development of Modern Civilization	(606)	3	*Ceramic Engineering Laboratory work in Enamels	(704)	5
*Metallurgy Advanced Metallography	(701)	4	*Ceramic Engineering Thesis	(710)	2	*Ceramic Engineering Thesis	(711)	4
						Ceramic Engineering Inspection Trip	(730)	0
		18			17			18

Glass Option

Third Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Physics Molecular Physics and Heat	(609)	4	Mechanics Statics	(601)	5	Mechanics Strength of Materials	(602)	5
Chemistry Physical Chemistry	(680)	3	Chemistry Colloid Chemistry	(695)	3	Mineralogy Thermochemical Mineralogy	(605)	4
World Literature		3	*Mineralogy Crystallography	(401)	3	*Mineralogy Descriptive	(402)	3
Fine Arts Appr. of Plastic Arts	(476)	1	Fine Arts Appr. of Pictorial Arts	(477)	1	Fine Arts Appr. of Popular Arts	(478)	1
Metallurgy Fuels	(651)	3	*Ceramic Engineering Glass Technology	( )	2	Ceramic Engineering Refractories and Furnaces	(610)	5
Ceramic Engineering Ceramic Calculations	(615)	5	Ceramic Engineering Bodies, Glazes, and Colors	(605)	4	Ceramic Engineering Inspection trip	(630)	0
		19			18			18

Glass Option

Fourth Year

Autumn Quarter			Winter Quarter			Spring Quarter		
Economics Principles of Economics for Engineers	(403)	3	Economics Principles of Economics for Engineers	(403)	3	Economics Labor Problems or	(410)	3
Accounting Outline of Accounting or	(405)	5	Bus. Organization Business Law; Contracts	(621)	3	Bus. Organization Ind. Organization and Management	(681)	3
Public Speaking Principles	(401)	3	Mineralogy Advanced Thermochemical	(606)	3	Journalism Trade and Technical Journalism	(413)	3
World Literature		3	World Literature		3	World Literature		3
Arts Survey Courses Development of Modern Civilization	(605)	3	Arts Survey Courses Development of Modern Civilization	(606)	3	*Ceramic Engineering Lab. Work in Glasses	( )	5
*Mineralogy Advanced Microscopic	(701)	5	*Ceramic Engineering Thesis	(710)	2	*Ceramic Engineering Thesis	(711)	4
						Ceramic Engineering Inspection Trip	(730)	0
		19			17			18

University of Illinois

First Year

First Semester			Second Semester		
Mathematics Mathematical Analysis or Mathematics Advanced Algebra and Mathematics Trigonometry	(1a) (2) (4 or 5)	5 3 2	Mathematics Mathematical Analysis or Mathematics Analytic Geometry	(1b) (6)	5 5
Chemistry Inorganic Chemistry	(1a or 1b)	3 or 4	Chemistry Qualitative Analysis	(4)	4
Engr. Drawing Elements of Drafting	(1 or 4)	4	Engr. Drawing Descriptive Geometry	(2)	4
Rhetoric Rhetoric and Themes	(1)	3	Rhetoric Rhetoric and Themes	(2)	3
Engineering Lecture		0	Engineering Lecture		0
Military Drill and Theory		1	Military Drill and Theory		1
Physical Education		½	Physical Education		½
Hygiene Hygiene and Sanitation (men)	(1)	½	Hygiene Hygiene and Sanitation (men)	(3)	½
		17 or 18			18

Second Year

First Semester			Second Semester		
Mathematics Differential Calculus	(7)	5	Mathematics Integral Calculus	(9)	3
Physics Lectures	(1a)	3	Physics Lectures	(1b)	2
Physics Laboratory	(3a)	2	Physics Laboratory	(3b)	2
Chemistry Quantitative Analysis	(5a)	5	Chemistry Quantitative Analysis	(5b)	5
Ceramics Ceramic Materials	(1)	3	English Exposition	(3)	3
Physical Education		½	Physical Education		½
Military Drill and Theory		1	Military Drill and Theory		1
			Mechanics Analytical Mechanics	(20)	3
		19½			19½

Clay Products Option

Third Year

First Semester			Second Semester		
Chemistry Physical Chemistry	(31)	3	Physics Heat Phenomena	(16)	3
Mechanics Resistance of Materials	(25)	4	Physics Heat Measurements	(36)	1
English Survey of English Literature	(1)	4	English Survey of English Literature	(2)	4
Art and Design History of Fine Arts	(19)	2	Art and Design History of Fine Arts	(20)	2
Public Speaking Principles	(1)	2	Economics Elements	(2)	3
*Ceramic Engineering Winning and Preparation	(2)	3	*Ceramic Engineering Designing and Shaping	(12)	3
			Ceramic Engineering Industrial Calculations	(3)	3
		18			19

CLAY PRODUCTS OPTION

Fourth Year

Business Law Law for Engineering Students	(3)	3	Business Organization Advanced Industrial Management	(4)	3
Geology General	(1)	4	Economics Personnel Administration	(43)	3
*Ceramic Engineering Drying and Firing	(4)	4	Public Speaking Business and Professional	(2)	2
Ceramic Engineering Glazes	(6)	6	*Ceramic Engineering Ceramic Construction	(9)	4
Ceramic Engineering Inspection Trip	(99)	0	*Ceramic Engineering Thesis	(98)	5
		17			17

ENAMEL OPTION

Third Year

First Semester			Second Semester		
Chemistry Physical Chemistry	(31)	3	Physics Heat Phenomena	(16)	3
Mechanics Resistance of Materials	(25)	4	Physics Heat Measurements	(36)	1
English Survey of English Literature	(1)	4	English Survey of English Literature	(2)	4
Art and Design History of Fine Arts	(19)	2	Art and Design History of Fine Arts	(20)	2
Public Speaking Principles	(1)	2	Economics Elements	(2)	3
			Ceramic Engineering Industrial Calculations	(3)	3
*Mechanical Engineering Pattern and Foundry Lab.	(85)	3	*Mechanical Engineering Pattern and Foundry Lab.	(86)	3
		18			19

ENAMEL OPTION

Fourth Year

First Semester			Second Semester		
Business Law Law for Engineering Students	(3)	3	Business Organization Advanced Industrial Organization and Management	(4)	3
Metallurgy Iron and Steel	(Chem. 7)	3	Metallography	(Chem. 78)	2
Geology General	(1)	4	Economics Personnel Administration	(43)	3
Public Speaking Business and Professional	(2)	2	*Ceramic Engineering Enamels	(16)	3
Ceramic Engineering Glazes	(6)	6	Ceramic Engineering Refractory Materials	(20)	2
Ceramic Engineering Inspection Trip	(99)	0	*Ceramic Engineering Thesis	(98)	3 or 5
		18			16 or 18

GLASS OPTION

Third Year

First Semester			Second Semester		
Chemistry Physical Chemistry	(31)	3	Physics Heat Phenomena	(16)	3
Mechanics Resistance of Materials	(25)	4	Physics Heat Measurements	(36)	1

Art and Design History of Fine Arts	(19)	2	Art and Design History of Fine Arts	(20)	2
Public Speaking Principles	(1)	2	Economics Elements	(2)	3
Geology General	(1)	4	*Geology Silicate Minerals	(48)	5
*Geology Systematic Mineralogy	(47)	3	Ceramic Engineering Refractory Materials	(2)	2
			Ceramic Engineering Iudustrial Calculations	(3)	3
		18			19

GLASS OPTION

Fourth Year

First Semester			Second Semester		
Business Law Law for Engineering Students	(3)	3	Business Organization Advanced Industrial Organization and Management	(4)	3
*Geology Optical Mineralogy	(6)	3	Economics Personnel Administration	(43)	3
English Survey of English Literature	(1)	4	English Survey of English Literature	(2)	4
Public Speaking Business and Professional	(2)	2	*Ceramic Engineering Glass Technology	(8)	2
Ceramic Engineering Glazes	(6)	6	*Ceramic Engineering Glass Laboratory	(15)	3
Ceramic Engineering Inspection Trip	(99)	0	*Ceramic Engineering Thesis	(98)	3
		18			18

The ceramic engineering courses taken in common by all the students are ceramic materials, ceramic calculations, refractories and furnaces, and the making of glazes. Those choosing the clay products option take also various courses in the manufacture of heavy clay wares and fine ceramic bodies. This course corresponds in general to the present courses in ceramic engineering, which are really courses in clay products technology.

In place of work in ceramic bodies, students choosing the enamel option take work in foundry practice, metallurgy, metallography, and enamel technology. The special studies for students choosing the glass option are elementary and advanced mineralogy, including microscopic mineralogy, and glass technology. The thesis work in each curriculum deals with some subject in the chosen option.

In the curriculum worked out from the Ohio State University catalogue, all the technical students take 88.73% of their work in common. This is distributed as follows:

Science	43.67%[1]
Allied Engineering	11.73
Business and Management	7.98
Cultural Studies	16.90
Ceramic Engineering	8.45
	88.73

The other 11.27% is devoted to special technical studies in one of the options. This added to ceramic technology in the common group gives a total for distinctly technical work of 19.72%.

[1] In figuring these percentages subjects such as military drill, hygiene, and physical education were excluded.

At the University of Illinois all students in ceramic technology would have 85.11% of their work in common, distributed as follows:

Science	39.72%
Allied Engineering	10.64
Business and Management	8.51
Cultural Studies	17.73
Ceramic Engineering	8.51
	85.11

The work in the technical options would amount to 14.59% and this added to the ceramic engineering would make a total for distinctly technical work of 23.40%. The higher percentage of technical work and the corresponding lower percentage of science is due to the fact that in the curricula for Ohio State University two excellent courses in thermochemical mineralogy are included in the science group. At the University of Illinois corresponding courses are not offered and, therefore, the percentage of ceramic engineering is increased.

The Committee feels that thorough training in chemistry and physics is fundamental to all technical work in ceramics. Therefore, it has included more of these two subjects than is ordinarily given in ceramic courses. It was thought 40% of the student's time should be devoted to fundamental sciences and 45 or 50% would not be an excessive proportion. In like manner, 16% is the minimum time that should be given to cultural studies.

On the other hand, the distinctly technical studies may be well confined to 20% of the student's time. When a graduate has had six months' experience in any particular line of ceramic manufacture, he will know more of the equipment, compositions, and methods of manufacture used in that specialty than it is possible to learn in any school. It is impossible for college instructors to anticipate the particular technical problems the graduates will encounter and to give them the solutions beforehand. As a result, the importance of versatility of mind in graduates and of thorough training in the fundamental sciences, on which the solutions of all technical problems depend, even though such training reduces the time allotted to direct instruction in ceramics, is emphasized.

From the above figures it is apparent that by having the students specialize in their technical work, it is possible to give them thorough training in the technical studies directly applicable to one division of the industry in a comparatively small amount of time. This gives room in the regular four-year college course for the indispensable cultural and business courses. If the curricula are not specialized and the colleges desire to graduate students with any appreciable amount of cultural studies and with a minimum amount of business courses and at the same time to have the students thoroughly grounded in the sciences and special technical studies necessary for work in the three main branches of the ceramic industry, it is inevitable that the college course must be extended to five years.

Importance of Cultural Courses

On account of their great importance the cultural courses included in these curricula are discussed in detail. It will be noted that the cultural studies are confined at the Ohio State University to English, literature, history, and art, with an option in public speaking. At the University of Illinois they are confined to English, public speaking, literature, and art. The ability to speak and write English is a valuable asset to a young engineer or technical man; therefore, English and public speaking are emphasized. Literature is included in both courses for its great cultural value. Foreign languages are omitted, not because the Committee thinks they have little cultural value, but because in the limited time an engineer or technical student can give to cultural work, the Committee believes

more can be gained by the study of English than of a foreign language. There is very little cultural value in struggling with the rudiments of grammar and syntax in a language.

The course in the Development of Modern Civilization in the curriculum for Ohio State University is taken from the catalogue of the College of Liberal Arts and in that College is required of all students specializing in subjects falling within the fields of biological and inorganic sciences. It is described as a course designed to afford the mature student some insight into the progress of thought in a great province of life to which he has given relatively little attention during his course. If such a course is desirable in the interest of broad education for arts students, it certainly is desirable for engineering students. A similar course is not inserted in the curriculum for the University of Illinois because none seems available.

The courses in "World Literature" shown in the curriculum for Ohio State University are also taken from the catalogue of the College of Liberal Arts. There are four of these courses: English Literature, German Literature, Latin and Greek Literature, Romance Literature. These courses are conducted in English by members of the staff of the various language departments and, with the exception of the course in English Literature, do not presuppose a knowledge of the language whose literature is being studied. Every student in the College of Liberal Arts must take at least two of these courses in the interest of broad, general culture. Since these are such excellent courses it would be well for technical students, who have so little cultural work compared to arts college students, to take all of them.

At the University of Illinois, an equivalent course does not seem to be available for undergraduates with little college training in English literature. If the Department of English Language and Literature could be persuaded to waive the present prerequisite requirements for English 54, this would be an excellent general cultural study for engineers. This course is described as follows: "Introduction to Comparative Literature: Introductory and Comparative Survey of the greatest Greek, Latin, Italian, Spanish, French, German and English authors."

This illustrates a disconcerting situation existing in many universities. The faculties of the Colleges of Liberal Arts are inclined to say that engineering graduates are lacking in culture. Yet at the same time, by the way they arrange their prerequisites and requirements, they practically exclude mature engineering students (those in the junior and senior classes) from broad cultural studies which might be of value to engineers.

Courses in appreciation of art are included in both curricula. Art to a ceramic technologist is of both cultural and business value. Whether a man is making common brick, glassware, or enameled tea kettles, he is making a product whose market value and saleability is determined to a large extent by its beauty. The Committee does not think it possible or desirable to make artists out of technical students, but it does feel that these students should have at least some formal training in the appreciation of art.

The cultural studies are confined to a few subjects in accord with the well-known pedagogical principle that it is better for a student to take work for three or four terms in one line of study, than to take one term's work in three or four different lines. For the same reason, electives chosen by the students are not included, for when students choose their own electives they are just as liable to choose a course because it comes at a convenient time, or because it is rated as a snap course, as they are to choose it for its real cultural value. In lieu of electives, it is suggested that students be allowed, with the approval of the Head of the Department of Ceramic Engineering, to make substitutions for cause and in kind in any part of these curricula. That is, if a student can give good reasons why he should substitute any course in engineering or technology for one of the courses in engineering or technology shown in the regular curriculum, he should be allowed to

do so. He should not, however, be allowed to substitute a course in technology or engineering for a course in cultural studies, or vice versa.

It will be noted that these curricula are called courses in ceramic technology rather than engineering. This is because they are courses intended to prepare a man for manufacturing ceramic products. The Committee is not in accord with some recent suggestions in ceramic literature that a technologist is simply a scientist or a laboratory worker with no fitness or ability for operating a plant. If we are to use English words, we must use them in their true lexicographical meaning and not make new definitions for them. By reference to any good dictionary, it can be determined that ceramic technology is the science or systematic knowledge of all the processes used in the manufacture of ceramic wares. It will also be found that engineering is the art of constructing and using machines or of doing work which requires a special knowledge or use of machinery or of the principles of mechanics. While machines are used in making ceramic products, a knowledge of machines and mechanics is only a small part of ceramic technology. Therefore, since it is believed that curricula similar to those it has proposed will give students a fundamental education which will enable them to understand and direct all the processes of ceramic manufacture, it prefers to call them curricula in *ceramic technology*.

Respectively submitted,

HOMER F. STALEY, *Chairman*
KARL TURK
H. D. CUSHMAN

Discussions

KARL TURK: I have carefully gone over the courses of studies of the different universities. If a young man will follow any of the courses outlined, he will get a thorough training in ceramics. The explanatory report covers the whole situation very thoroughly.

There is a question in my mind, however, regarding a questionnaire, which could be submitted to some of our ceramic engineers who are holding responsible positions now, putting the question up to them as to what they have missed in their college training that would help them in their present positions. It might bring to light some very interesting data, helpful to formulate the policies for the Committee on Education.

It would, of course, be too late at this time to hold up the report for these data, but might at some future time be valuable.

H. D. CUSHMAN: I have one suggestion to make and that is in the line of a principle rather than a specific suggestion. I am firmly of the mind that a thorough grounding and advance study in fundamentals would be a great deal more valuable to students than any specific knowledge which they can acquire.

To make my meaning clear, a student wishing to follow the enamel industry in any of its branches as it is organized today must be grounded in mechanics, engineering, chemistry, and physics. He must have not only the rudiments but all of the advanced work that the colleges can give him.

I do not think, therefore, that the proportion of 45% of his time for the fundamental sciences is any too high. In fact I would rather have a man who had devoted his entire college course to a thorough training in the fundamental sciences, along with cultural development, than I would to have a man who devoted his time to the specific investigations of enamel or clay or any other ceramic industry.

I have found that it is almost impossible to use in our research laboratory any graduate from ceramic schools unless he has had a supplementary education either by post graduate work or years of experience.

When I am looking for a man for our organization, today, I go outside of the ceramic school graduates and attempt to find a man who has a straight B.S. degree or at least has specialized during his whole term of preparation in the fundamental sciences.

Given such a man I can make a ceramist or enamel technologist of him in six months time.

It would be well to emphasize a little more strongly the study of the appreciation of art. This is a very colorful age and everybody seems to live color as well as put it on their ceramic ware of whatever nature it is. Color has come to stay. The age of white enamel has been outlived and colors will play an important part. Therefore, an appreciation of art as applied to ceramics would save us from many of the errors of color combinations that we are now making.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM MAY 1 TO JUNE 1

CORPORATION

Fiske and Co., Inc., Mfrs. Face Brick, 115 Federal St., Boston, Mass., James W. Libby, Representative.

PERSONAL

John D. Beebe, Isolantite Company of America, Inc., 343 Cortlandt St., Belleville, N. J.

William S. Dyer, Asst. Provincial Geologist, Dept. of Mines, Queen's Park, Toronto, Canada.

Charles M. Harder, Instructor, N. Y. State School of Clayworking and Ceramics, Alfred, N. Y.

John Ronald Howie, Asst. Manager, Fireclay manufacturers, Templetonburn, Kilmarnock, Scotland.

Roy T. Hurley, The Moto-Meter Co., Inc., Eng. Dept., Spark Plug Div., Long Island City, N. Y.

August F. Kammer, Vice President and Manager, N. Y. Office, Carr-Lowrey Glass Co., 41 E. 42nd St., New York City.

Frank L. Knapp, Contracting Mason (fire brick, boilers, kilns), 1003 N. Avenue 49, Los Angeles, Calif.

Rostislav S. Korbanovsky, Vice Director, Ukrfarfor Trust, Kiev, 32 Piatakov St., U.S.S.R.

Johann W. Ludowici, Roofing tile, Jockgrim, Palatinate, Germany.

C. Herbert Thompson, Director and Consulting Chemist, The Thompson Laboratories, Mount Battenhall, Worcester, England.

STUDENT

Dwight G. Bennett, Univ. of Ill., Urbana, Ill.

William Horak, Univ. of Ill., Urbana, Ill.

J. H. Thomas, Univ. of Ill., Urbana, Ill.

Membership Worker's Record

	CORPORATION		STUDENT
Office	1	J. J. Svec	2
	PERSONAL	T. N. McVay	1
Paul R. Babcock	1		—
W. Emery	1	Total	3
Marion L. Fosdick	1	Grand Total	14
Karl Hart	1		
R. D. Landrum	1		
C. B. McComas	1		
R. J. Montgomery	1		
R. E. Sturtevant	1		
J. B. Zeldes	1		
Office	1		
	—		
Total	10		

AMERICAN CERAMISTS IN EUROPE

The following persons sailed on the S. S. Tuscania on May 19, 1928, for the six-weeks' European Tour sponsored by the AMERICAN CERAMIC SOCIETY.

Arthur J. Bennett, Trenton, N. J.

McDonald C. Booze, Chas. Taylor Sons, Cincinnati, Ohio. (President, AMERICAN CERAMIC SOCIETY.)

George H. Brown, Secy., N. J. Clayworker's Assn., New Brunswick, N. J.

Mr. and Mrs. D. A. Cable, United States Quarry Tile Co., East Sparta, Ohio.
William Cannan, Onondaga Pottery Co., Syracuse, N. Y.
Mr. and Mrs. Frederick Carder, Corning Glass Works, Corning, N. Y.
Wm. H. Crume, Crume Brick Co., Dayton, Ohio.
Mr. and Mrs. T. S. Curtis, The Vitrefrax Co., Los Angeles, Calif.
Mr. and Mrs. and Miss Alice Dedouch, J. A. Dedouch Co., Oak Park, Ill.
Mr. and Mrs. Theo. C. Denis, Quebec Bureau of Mines, Quebec, Can.
Geo. W. Denison, Ohio Clay Co., Cleveland, Ohio.
J. F. Early, Akro Agate Co., Clarksburg, W. Va.
R. E. Elliott, Canadian Potteries Ltd., St. Johns, Quebec.
William S. Emley, Rutgers College, New Brunswick, N. J.
Charles R. Essick, Willson Goggles, Reading, Pa.
Miss Mabel Farren, Wilkinsburg, Pa.
J. Earl Frazier, Simplex Engineering Co., Washington, Pa.
Mr. and Mrs. A. P. M. Fleming, Metropolitan Vickers Co., Manchester, Eng.
Clarence E. Fulton, Pittsburgh Plate Glass Co., Creighton, Pa.
Charles B. Garwood, Carr-Lowrey Glass Co., Baltimore, Md.
William Garwood, Baltimore, Md.
M. A. Gesner, Hammill & Gillespie, New York City.
B. D. Hardesty, Mayer China Co., Beaver Falls, Pa.
Henry R. Hellmers, Akro Agate Co., Clarksburg, W. Va.
W. H. Henson, Univ. of Illinois, Champaign, Ill.
E. L. Hettinger, Willson Goggles, Reading, Pa.
Carl G. Hilgenberg, Carr-Lowrey Glass Co., Baltimore, Md.
Mr. and Mrs. F. E. Hodek, Jr., General Porcelain Enameling & Mfg. Co., Chicago, Ill.
Misses Betty and Carroll Hood, Atlanta, Ga.
Wm. G. Jackson, Jr., Empire China Co., Los Angeles, Calif.
S. E. Josi, Celite Products Corp., London, Eng.
Koji Kato, Imperial Steel Works, Yawata City, Japan.
J. R. Kauffman, Miamisburg, Ohio.
W. C. Kempf, Rutgers College, New Brunswick, N. J.
N. P. Krasnikoff, Moscow, U. S. S. R.
Mr. and Mrs. G. W. Lapp, Lapp Insulator Co., LeRoy, N. Y.
Francis D. McNerney, Bradford, Pa.
Mr. and Mrs. F. W. Moffat, Moffats Ltd., Weston, Ontario.
Richard S. Moore, Univ. of Ill., Champaign, Ill.
Mr. and Mrs. Stuart M. Phelps, Mellon Institute, Pittsburgh, Pa.
Mr. and Mrs. Wm. L. Phillips, N. Clark & Sons, San Francisco, Calif.
Mr. and Mrs. Arthur J. Podmore, Camden Pottery Co., Camden, N. J.
Amos P. Potts, Clay Products Co., Brazil, Ind.
Ross C. Purdy, Secy., AMERICAN CERAMIC SOCIETY, Columbus, Ohio.
Ebon Rodgers, Jr., Alton Brick Co., Alton, Ill.
W. L. Shearer, Rutgers Univ., New Brunswick, N. J.
Alexander Silverman, Univ. of Pittsburgh, Pittsburgh, Pa.
George Simcoe, Edgar Plastic Kaolin Co., Metuchen, N. J.
Ralph O. Smith, Salem Glass Works, Salem, N. J.
Frederick Sutterlin, Scammell China Co., Trenton, N. J.
Jay and Albert J. Terry, Terry Brick Co., Kingston, N. Y.
Mrs. Edmonson Warrin, New York City.
J. D. Wilcox, Alliance Clay Products Co., Alliance, Ohio.
T. A. Willson, Willson Goggles, Reading, Pa.
Carl H. Zwermann, Jr., Robinson, Ill.

PERSONAL NOTES OF MEMBERS OF THE SOCIETY

The American Foundryman's Association has moved from 140 S. Dearborn St. to Room 865, 222 West Adams St., Chicago, Ill. (C. E. Hoyt is Secretary of this Association).

R. E. Arnold was mistakenly reported in the May *Bulletin* to be in the employ of the W. S. Dickey Clay Manufacturing Co., Kansas City, Mo. Mr. Arnold is conducting test

work on sewer pipe kilns in various parts of the country in connection with his research work at Mellon Institute of Industrial Research, Pittsburgh, Pa.

Edwin P. Arthur is now located at Morgantown, W. Va., Box 301, A4.

Walter F. Bond has moved from Buffalo, N. Y. (American Radiator Co.) to Cleveland, Ohio, where he is affiliated with the Ferro Enameling Co.

Martin S. Bowne is located at Clearfield (Rowan Co.) Ky., as general manager of the Lee Clay Products Co.

Canadian Chemistry and Metallurgy, published in Toronto, Can., has moved from 40 Richmond St., to 366 Adelaide St., W. Toronto 2, Ont.

The Clay Products Association (Geo. C. D. Lenth, Secretary) has moved from the Chamber of Commerce Bldg. to Room 1847, 111 W. Washington St., Box 2, Chicago, Ill.

H. D. Carter has accepted a position as chemist for the Canton Stamping & Enameling Co. of Canton, Ohio. Mr. Carter was formerly chemist with the Ferro Enameling Co., Cleveland, Ohio.

J. C. Cromwell of Columbus, Ohio, has moved to Alliance, Ohio, where he is associated with The Steel Sanitary Company.

W. K. Cronin, recently with the Standard Pottery Co., East Liverpool, Ohio, is now with the Cronin China Co., New Cumberland, W. Va.

R. R. Fusselbaugh has moved from Woodlawn, Md., to Royersford, Pa., where he is affiliated with the Buckwalter Stove Company.

John H. Grady, recently of St. Louis is situated at Black Lick, Ohio, with the Claycraft Mining and Brick Co.

The Hollow Building Tile Association (J. S. Sleeper, Secretary), has moved from the Conway Bldg., to 205 W. Wacker Drive (Canal Station), Chicago, Ill.

J. C. Hostetter, Trustee Representative for the Glass Division of the AMERICAN CERAMIC SOCIETY has been transferred from Central Falls, R. I. Division of the Corning Glass Works to Corning, N. Y., as Manager of the Bulb and Tubing Department of the same company.

Henrietta Ord Jones has been made Professor Emeritus of Ceramics at Washington University, St. Louis, Mo. She has established her own pottery, the "H. O. J. Pottery," at 5531 Suburban Tracks, fully equipped for work with two kilns, wheels, motors, etc.

R. B. Keeler's present address is Malibu Potteries, Box 518, Santa Monica, Calif.

F. A. Kirkpatrick of Kansas City, Mo., has moved to Unionville, Mich.

A. V. Lawton has been appointed to take the place of Philip H. Cruikshank as corporation representative of the Mueller Co., Decatur, Illinois.

Henry E. Marley, formerly ceramic engineer for the Koppers Co. Laboratories, Pittsburgh, Pa., has moved to Elyria, Ohio, c/o Harshaw, Fuller, and Goodwin Co.

C. C. Mayfield (Tiffin, Ohio) is now employed by the Ohio Northwestern Gas Co., Toledo, Ohio (23 Huron St.)

On May 1, 1928 the New Jersey Terra Cotta Company (formerly Singer Building) and the South Amboy Terra Cotta Company (formerly 150 Nassau St.) merged into one company known as the **New Jersey Terra Cotta Company.** The new offices are located at 299 Madison Ave., New York City.

W. N. Noble, formerly associated with the Seeger Refrigerator Company, St. Paul, Minn., is now employed with the Chicago Vitreous Company. Mr. Noble's address is 1127 South Harvey Ave., Oak Park, Ill.

James F. Phillips, (Middletown, Ohio) is associated with the Department of Mines, Ottawa, Canada.

Edward W. Scripture, Jr. has moved from Syracuse, N. Y., to 29 Henry Street, Glen Rock, N. Y.

Paul Slegel, former student at Iowa State College, Ames, Iowa, has moved to Maryville, Tenn., Evans Hotel.

W. W. Tsou, member of this SOCIETY since 1923, after spending last year at the University of Sheffield, Sheffield, England, has been appointed president of the ceramic school of Kiangsi, Poyang, Kiangsi, China.

J. H. Weis, formerly ceramic engineer with the Mansfield Vitreous Electric Company, Mansfield, Ohio, has moved to Cranberry Creek, Fulton County, N. J., where he is ceramic engineer in charge of technical control of the United States Feldspar Corporation.

The Western Society of Engineers (Edgar S. Nethercut, Secy.) has moved from Monadnock Block, Chicago, Ill. to Room 1200, 205 West Wacker Drive (Canal Station).

AMONG THE LOCAL SECTIONS

Pittsburgh Section

The Pittsburgh Section of the AMERICAN CERAMIC SOCIETY held an interesting meeting, Tuesday evening, June 12, in the Fellows' Room of Mellon Institute. F. H. Riddle of Detroit, Mich., gave an instructive talk on the uses of sillimanite in ceramics.

Among those present were Carl B. Harrop, Columbus, Ohio; W. W. McDanel, Beaver Falls, Pa.; J. Spotts McDowell, Harbison-Walker Refractories Co., Pittsburgh; N. A. Rabe and Geo. R. Robey, Cambridge Sanitary Mfg. Co.; Robert C. Boyd and R. J. Paddock, Standard Sanitary Mfg. Co.; H. M. Kraner and R. F. Barrett, Westinghouse Electric and Mfg. Co.; W. Keith McAfee, Universal Sanitary Co.; Fred Sauerensen, Technical Products Co.; H. F. Bopp and H. Sheerer, Vitro Mfg. Co.; C. L. Jones, Vesuvius Crucible Co.; G. E. Crawford and P. D. Helser, Eljer Co., Ford City, Pa.; John Allingham, Pittsburgh, Pa.; and S. S. Cole, C. E. Parmelee, S. M. Swain, J. H. Waggoner, Geo. Walther, C. G. Denney, R. F. Ferguson, A. C. Hughes, Geo. R. Daniel, V. S. Cartright, E. J. Casselman, R. E. Arnold, J. L. Young, and C. A. Walworth of Mellon Institute.

Pacific Northwest Section

Members of the Pacific-Northwest Section will hold their summer meeting at Yakima, Wash., August 31 and September 1. All members of the SOCIETY are invited to attend this meeting.

OBITUARY NOTICES

E. E. F. Creighton[1]

Word has been received of the death of Elmer Ellsworth Farmer Creighton, General Electric Company, Schenectady, N. Y.

During the greater part of that period he was a technical associate and a personal friend of the late Dr. Charles Proteus Steinmetz. Together they studied lightning in its relation to electric power transmission; but Prof. Creighton also performed much independent engineering work in this field.

He was educated at Leland Stanford University, graduating in 1895, and receiving

[1] Taken from *Gen. Elec. Rev.*, March, 1928.

the degree of Electrical Engineer in 1897. These early years were divided between service as special testing engineer for the Pacific Postal Telegraph Company, teaching at his alma mater, and assisting Dr. David Starr Jordan on the Fur Seal Commission among the Pribilof Islands, Alaska.

E. E. F. CREIGHTON

From 1898 to 1900, he was assistant to Andre Blondel, in the Sorbonne, Paris, and at the Ecole Superieure d'Electricite. Upon returning to this country he again taught, for a time, at Leland Stanford.

In 1901, Prof. Creighton became the head of the Experimental Department at the Stanley Electric Manufacturing Company's plant at Pittsfield, Massachusetts, removing to Schenectady in 1904 to become assistant professor to Dr. Charles P. Steinmetz, who was at that time the head of the Electrical Engineering Department at Union College.

In 1913, a research laboratory for investigating protective methods, which Prof. Creighton had assisted in conducting at Union College in behalf also of the General Electric Company, was moved to the General Electric Works, and was made part of Dr. Steinmetz's consulting engineering department. A few years ago this laboratory was combined with the Standardizing Laboratory to form the present General Engineering Laboratory, under which Prof. Creighton had since served.

Prof. Creighton was a contributor to the electrical engineering profession both by inventions and by technical papers. He held sixty-six United States patents, almost all in the field of protective devices. These were principally the aluminum arrester, the compression-chamber arrester, the dry-film arrester, concrete reactors, and several types of direct-current and alternating-current arresters.

He served on many technical committees, particularly those on meetings and papers and on protection for the A.I.E.E., as well as on several American engineering standards committees. Since 1906, he had contributed more than seventy-five technical papers and discussions to the transactions of the A.I.E.E.

He was a Fellow of the American Institute of Electrical Engineers, a member of the Society for the Promotion of Engineering Education, the American Association for the Advancement of Science, the National Electric Light Association, the American Society of Mechanical Engineers, the American Physical Society, the American Electro-Chemical Society, the AMERICAN CERAMIC SOCIETY since 1914, and the Society Francaise des Electriciens. He was also a member of the Sigma Xi fraternity.

Arthur A. Houghton

Death came to Arthur A. Houghton, 61 years of age, April 20. Mr. Houghton was a former president of the Corning Glass Works and the son of Amory Houghton who founded the company.

David Yost

David Yost, vice president of the U. S. Glass Co., of Pittsburgh died recently at the age of 67 years. He had been affiliated with that company since 1901, on its board of directors since 1908, and was vice president from 1920 until the day of his death.

E. E. Myers

E. E. Myers, former general manager of the Brookville Glass and Tile Co., died April 22 at Brookville, Pa. He was one of the founders of the Pennsylvania Window Glass Co. at Kane, Pa., of which he became manager in 1904. In 1923 he resigned from the first-named position which he had held since 1913. Mr. Myers had been a member of the AMERICAN CERAMIC SOCIETY since 1920. His membership has been transferred to his brother, Earl R. Myers.

Ralph J. Douglas

Ralph J. Douglas, member of the AMERICAN CERAMIC SOCIETY since 1921, died in January of this year. Mr. Douglas was associated with the John Douglas Company, Cincinnati, Ohio.

Clarence D. Giacomini

Word has been received of the death of Clarence D. Giacomini of Leavenworth, Kans. Mr. Giacomini was in charge of the enamel department of the Greta Western Stove Company and had been a member of the SOCIETY since 1923.

NOTES AND NEWS

NOTES FROM THE CERAMIC SCHOOLS

New York School of Clayworking and Ceramics

The senior class of ceramic engineering students at the N. Y. School of Clayworking and Ceramics, Alfred, N. Y. made an inspection trip of several ceramic plants on May 1, 1928. The plants visited were (1) Lapp Insulator Co. of LeRoy; (2) Liske Enameling Co. of Canandaigua, N. Y.; and (3) Taylor Instrument Co., of Rochester, N. Y. There were fourteen in the inspection party, and the trip extended over two hundred and fifty miles.

The senior theses for this year are as follows:

Ally: "Application of Terra Cotta without the Use of Engobes."
Fulmer: "The Use of Raw Materials in Making Vitreous Floor Tiles."
Stolte and Collins: "Low Fire Vitreous Floor Tile."
Williams: "The Relation between the Expansion Curve and the Heat Curve of Setting Plaster of Paris."
Saunders: "The Effect of the Size of Grain on the Strength of Heavy Clay Bodies in the Dry and Fired States."
Luks: "The Use of Selenium for a Red Glaze to be Used on China Bodies."

The following art students have positions for the summer to teach pottery or other crafts in camps, etc.:

GRADUATES

Eleanor Craig	Highland Nature Camp	
Grace Hutchinson	Camp Aloha	Fairhe, Vt.
Harriet Saunders	Camp Pen-Rab	Old Forge, N. Y.

	SENIORS	
Elizabeth Selkirk	Luther Culich Camps	South Casco, N. Y.
Dorothy Holland	Camp Tegaurtha	
Florence Potter	Mt. Pocono	Pa.
Winifred Love	Highland Nature Camp	
	JUNIORS	
Ruth Claire	Lanier Camp	Eliot, Maine
	SOPHOMORES	
Harriet Mills	Camp Aloha	Fairhe, Vt.
Dorothy Hallock	Camp Pen-Rab	Old Forge, N. Y.

This year the Kanakadea year book, Alfred University, published by the Junior Class, has ceramics for its theme. It is dedicated to Charles F. Binns, beloved and honored Director of the Ceramic School.

Iowa State College

The ceramic students at Iowa State College made their annual contribution to the "Veishea" parade, in which the different organizations participate each year. The figure which was placed on the ceramic float was a reproduction in plaster of Paris of a Chinese porcelain representing the God of Longevity, a benevolent personage, whose long head and ears typify the popular concept that a person so favored is due for a very long life.

The figure was painted in glossy paints to resemble glazed porcelain, with the head and hands resembling a yellowish biscuit, in both texture and color.

A clay model was first made, from which a plaster cast was made, body and head in two parts. From the clay model plaster casts were made and from these the final casts were taken. The hands were made by firing the original clay modelings cut from the figure and bolting on the

FIG. 1.—Float for Iowa State "Veishea" parade.

plaster cast. About one thousand pounds of plaster were used in the final casts, although the figure and head were hollow.

The colors were blue, turquoise, yellow, and the flat yellowish tint for the head and hands. The float bore the titles, with a dragon embellishment in blue, vermillion, yellow, and green.

The modeling and the titles were done under the direction of Miss Mary L. Yancey, professor in the department. Vases of plaster of Paris on the float were made by the engineering students. The students worked from one to five hours every day in their leisure time during the Spring Quarter up to the day of the parade.

The figure represents probably the most ambitious use of plaster of Paris in any of the ceramic schools to this time. It is now located in the formal garden of the Department of Landscape Architecture. It will be used to determine the value of such material for garden work. These paints give results very comparable with tin enamels and it is apparent that the terra cotta firms might find it profitable to depart from the mat glazes for garden terra cotta work.

The engineering students also produced three thousand little milk pans of the old French pan form, which they gave away to the visitors at the open house exhibition.

University of Cincinnati
School of Applied Arts
Ceramics

Ceramics-Five-Year Coöperative Plan for Men

Courses required for the Degree of Bachelor of Science in Ceramics. (The Freshman and Sophomore years are given under Architecture.)

THIRD YEAR (Pre-Junior)

Subject	Credit Hours 1st Term	2d Term	Summer
Background			
History of Rennaissance and Modern Architecture	3	3	
Modern Civilization	3	3	
Historic Literature	2	2	2
Music Lecture	1	1	
Theory and History of Art	1	1	
Principles			
General Inorganic Chemistry	6	6	
Principles of Ceramics	1	1	1
Mediums of Presentation			
Freehand Drawing	3	3	
Outdoor Sketching			4
Materials			
Coördination	1	1	
Mold Construction			3
Transfer Printing Plates			3
Creative Problems			
Ceramic Design	3	3	3
Ceramic Laboratory	2	2	2
Other Courses			
*Military Science and Tactics	2	2	2

FOURTH YEAR (Junior)

Subject	Credit Hours 1st Term	2d Term	Summer
Background			
History of Ceramics	3	3	
Music Lecture	1	1	

* Required the first and second years through second summer; elective in third fourth and fifth years

Subject	Credit Hours 1st Term	2nd Term	Summer
Principles			
Principles of Ceramics-Calculations	2	2	
Mediums of Presentation			
Freehand Drawing	3	3	
Outdoor Sketching	–	–	4
Modeling	1	1	
Materials			
Sheet Metal Working and Stencil Construction			3
Clay: Occurrence, Properties, and Shaping	2	2	
Ceramic Laboratory	3	3	6
Creative Problems			
Ceramic Design	4	4	4
Other Courses			
*Military Science and Tactics	2	2	2

FIFTH YEAR (Senior)

Subject	Credit Hours 1st Term	2d Term
Background		
Music Lecture	1	1
Principles		
Drying and Firing Clay Wares	1	1
Professional Practice	2	2
Mediums of Presentation		
Freehand Drawing	3	3
Materials		
Ceramic Laboratory	5	5
Creative Problems		
Ceramic Design	6	6
Other Courses		
*Military Science and Tactics	2	2

Ceramics Four-Year Regular Plan for Women

Courses Required for the Degree of Bachelor of Science in Ceramics.

FIRST YEAR (FRESHMAN)

Subject		Credit Hours 1st Term	2d Term
Background			
Sources and Development of Art		6	6
(1) Historical Background	2 credits		
(2) Development and History of Arts	2 credits		
(3) Historic Literature, with practice in writing	2 credits		
English (a supplementary course required of all students who need extra work in English). One hour, no credit.			
French		3	3
Music Lecture		1	1
Principles			
Principles of Design		2	2
Principles of Design (color)		1	1
Mediums of Presentation			
Freehand Drawing		2	2
Modeling		1	1
Architectural Design		1	1
Materials			
No Specific courses in composition of materials in the Freshman year; quality of materials, however, is emphasized in connection with the Principles of Design.			

Subject	Credit Hours 1st Term	2nd Term
Creative Problems		
Not a special course until third and fourth years. The creative emphasis in design in years one and two comes under Principles of Design, A. A. 19, and Principles of Design (Color), A. A. 19.1.		
Other Courses		
Physical Education	1	1

SECOND YEAR (Sophomore)

Subject	Credit Hours 1st Term	2d Term
Background		
Sources and Development of Art	6	6
(1) Historical Background	2 credits	
(2) Development and History of Arts	2 credits	
(3) Historic Literature, with practice in writing	2 credits	
History of Ornament	1	1
French	3	3
Music Lecture	1	1
Principles		
Principles of Design	3	3
Principles of Design (color)	1	1
Mediums of Presentation		
Freehand Drawing	1	1
Modeling	1	1
Ceramics	1	1
Creative Problems		
Not a special course until third and fourth years. The creative emphasis in design in years one and two comes under Principles of Design A. A. 29 and Principles of Design (color). A. A. 29. 1.		
Other Courses		
Physical Education	1	1

THIRD YEAR (Junior)

Subject	Credit Hours 1st Term	2d Term
Background		
Sources and Development of Art	3	3
Music Lecture	1	1
Principles		
Principles of Ceramics	1	1
General Inorganic Chemistry	3	3
Mediums of Presentation		
Freehand Drawing	1	1
Materials		
Transfer Printing Plates	2	
Sheet Metal Working and Stencil Construction		2
Mold Construction	2	2
Ceramic Laboratory	2	2
Creative Problems		
Ceramic Design	3	3

FOURTH YEAR (Senior)

Subject	Credit Hours 1st Term	2d Term
Background		
Sources and Development of Art	3	3
History of Ceramics	2	2
Music Lecture	1	1

Subject	Credit Hours 1st Term	2nd Term
Principles		
Principles of Ceramics–Calculations	1	1
Drying and Firing Clay Ware	1	1
Professional Practice	1	1
Mediums of Presentation		
Freehand Drawing	3	3
Modeling	1	1
Materials		
Clay: its occurrence, properties, and methods of shaping	1	1
Ceramic Laboratory	3	3
Creative Problems		
Ceramic Design	5	5

CERAMICS

(Professor Nash)

22*a*, *b* Ceramics

A laboratory course in the production of hand-built articles of clay. The work is planned to develop a feeling for the material as a medium of expression, and to acquaint the student with the fundamental processes employed in shaping and decorating it.

30*c* Mold Construction

A laboratory course, with some lectures, of plaster mold construction to meet the needs of the casting, pressing and jiggering processes. Besides actual mold-making practice, attention is given to general principles in order to develop resource which can cope with other than traditional problems.

31*a*, *b*, *c* Principles of Ceramics

A survey of the products of clay, glass, and enameled metal, with a study of the aesthetic appeal and functional suitability of each product in relation to the nature and limitations of its material. (Lantern slides to be used in the course, as well as actual specimens of ceramic ware. Trips to deposits of raw materials, manufactories, and displays of completed ware.)

32*a*, *c* Transfer Printing Plates

A laboratory course in the production of steel plate etchings for transfer printing on glass, glaze, and enamel. Lectures and reading assignments on other mechanical and chemical methods of transfer printing, such as, lithography, photo-engraving, etc.

32*a*, *b*, *c* Ceramic Laboratory

A laboratory course for the execution of some of the problems designed in Cer. 33*a*, 33*b*, 33*c*.

36*a*, *b*, *c* Ceramic Design

The design of hand-built and wheel-thrown pottery, and of other hand-made articles of clay. Special attention is given to good line, and to patterns of one color.

41*a*, *b* Principles of Ceramics–Calculations

A course in ceramic arithmetic, and the principles underlying its use. Particular attention is given to the calculations involved in the composition and control of bodies, glazes, and colors.

44*a*, *b*, *c* Ceramic Laboratory

A laboratory course for the solution of body, glaze, and color problems arising in Cer. 46*a*, 46*b*; and for the execution of certain designs completed in Cer. 43*a*, 43*b*, and 43*c*.

45*a*, *b* History of Ceramics

A lecture course on the development of ceramic ware from ancient times to the present. A required part of the course consists of illustrating the notebook work with examples of historic wares taken from library sources.

46*a*, *b*, *c* Ceramic Design

A combined lecture and laboratory course in the design of ceramic ware. Problems this year are more advanced and begin to take into consideration certain limitations imposed by industrial methods of manufacture.

47*b*, *c* Sheet Metal Working and Stencil Construction

A combined lecture and laboratory course in the production of simple and intricate copper stencils for decorating clay and glass wares. The work includes the shaping and cutting of stencils to fit irregular shapes, methods of making bridged and hinged stencils, and blowpipe soldering.

48*a*, *b* Clay: Its Occurrence, Properties, and Methods of Shaping
A lecture course to include the occurrence, properties, and industrial methods of shaping clay.

53*a*, *b* Professional Practice
A course in factory methods, including labor management and blueprint reading.

54*a*, *b* Ceramic Laboratory
A laboratory course for the solution of glaze and color problems, and for the execution of designs completed in Cer. 53*a* and 53*b*.

56*a*, *b* Ceramic Design
Advanced problems in ceramic design. Problems will include sketches of all necessary equipment for their execution, a description of the technique involved, and an intelligent outline of the method for obtaining the necessary bodies, colors, and glazes. Some of the problems will be carried out in the laboratory.

59*a*, *b* Drying and Firing Clay Wares
A course in the principles that underlie the successful drying and firing of clay wares. Practice in firing the school kilns.

Ceramics at Sebring High School

The following report is given of the theories, aims, and needs of the ceramic department, established this last year at McKinley High School, Sebring, Ohio. The report is signed by Samuel H. Pollock, Superintendent of Schools and L. G. Tait, Instructor in Ceramics.

Acknowledgment is made to G. A. Bole, Ohio State University and V. J. Roehm, Sebring Pottery Co., Sebring, Ohio, for help in gathering materials and information, and to Raymond Green, Gem Clay Company for furnishing the more uncommon minerals for experimental use.

Aims

The sole aim of the course is to help the boy to be a more valuable employee, benefiting primarily the boy and, secondarily, the employer. This was to be accomplished by developing:

(1) Character Qualities
- (*a*) Honesty in performing and reporting experiments.
- (*b*) Fidelity, in obeying instruction even when unpleasant to do so.
- (*c*) Coöperation, neither "hogging" the work for praise nor shirking it through laziness; "the group spirit."
- (*d*) Initiative.
- (*e*) Restraint of excess initiative, only when an excess is detrimental to efficacy in routine operations.

(2) Work Habits
- (*a*) Accuracy, in thought and performance.
- (*b*) Thoroughness, complete everything started.
- (*c*) Cleanliness.
- (*d*) Punctuality (regularity).

(3) General ceramic information. As Sebring is essentially a whiteware manufacturing center the greatest attention is given to this branch of ceramics.
- (*a*) Theoretical: Chemical and physical operations.
- (*b*) Practical: " " " "
- (*c*) Relation of (*a*) and (*b*).

(4) Curiosity.
- (*a*) What happens under given conditions.
- (*b*) Why it happens.

(5) Interest. This last was considered the most important for the beginners as the accomplishment of all the other aims hinges on it.
- (*a*) Fabrication of odd pieces.
- (*b*) Field trips.
- (*c*) Method of teaching.

Division of Time

For one high school credit, federal law requires four forty-two minute periods of shop work five days a week. It was decided that one of these periods be devoted to ceramic theory, the remaining three, which make up the whole school afternoon, devoted to the manual. This gives a ratio of one theory to three practice, or one practice unit more than the minimum advised by universities. Because of the relative immaturity of high school student this extra practice period was thought advisable.

An outline of accomplishments in each branch follows: the theory first.

Ceramic Theory

The subjects covered and results obtained can be grouped roughly under the following subheads. During the year these were not taken and completed separately but necessarily studied jointly.

1. Ceramic History. A very brief history from Egyptian and Chinese to the present.
2. Elementary Chemistry.
   - (*a*) Element and compounds.
   - (*b*) Atoms and molecules.
   - (*c*) Chemical symbols and their use.
   - (*d*) Balancing simple equations as:
     Given $H+O \rightarrow H_2O$
     Corrected $2H+O \rightarrow H_2O$
     Given $Fe+O \rightarrow Fe_2O_3$
     Corrected $2Fe+3O \rightarrow Fe_2O_3$
     Given $Na\ CO_3+HCl \rightarrow NaCl+H_2O+CO_2$
     Corrected $Na_2CO_3+2HCl \rightarrow 2NaCl+H_2O+CO_2$
   - (*e*) Metals and nonmetals.
   - (*f*) Acids, alkalis, and bases.
   - (*g*) Atomic weights.
   - (*h*) Substitution by use of atomic weights. (*i.e.*, for 10 lbs. of PbO equivalent how much $PbCO_3$ would you use.)
3. Geology:
   - (*a*) Comparative composition of the earth's crust.
   - (*b*) Rock forms. (1) igneous; (2) sedimentary; (3) metamorphic.
   - (*c*) Weathering and its results.
   - (*d*) Method of clay deposition.
   - (*e*) Resulting forms or kinds of clay.
4. Body triangle:
   - (*a*) Fluxes
   - (*b*) Plastics
   - (*c*) Refractories

   } What they are and what effect they have (eutectic action)
5. Type bodies:
   - (*a*) Why a body is expressed by the batch formula and not by a chemical formula.
   - (*b*) Dictation of a series of type body formulas, their firing temperature, and the kind of ware produced.
6. Raw materials studied:
   - (*a*) Chemically.
   - (*b*) Geographically.
   - (*c*) Action under heat.
7. Type glazes:
   - (*a*) Kinds.
   - (*b*) Why they can be expressed by chemical formulas.
   - (*c*) Method of developing a batch from a chemical formula.
   - (*d*) Application to various bodies.
   - (*e*) Dictation of a series of type glazes.
8. Heat.
   - (*a*) The kiln.
   - (*b*) Heat measuring appliances.
   - (*c*) Centigrade, Fahrenheit, and their transposition.
9. Ceramic terms: accomplish through constant use rather than by lectures or reading.

(10) Miscellaneous: Resulting through questions asked by students.
- (*a*) Plaster: (1) quantity mix; (2) safe dry temperature; (3) strength; (4) deterioration under use with a water solution of soda ash and sodium silicate.
- (*b*) Why of a pyrometer: (1) resistance type; (2) ponteniometer type; (3) optical type; (4) optical radiation type.
- (*c*) Practical tests for feldspar.
- (*d*) Coloring oxides.
- (*e*) Saggers: (1) composition; (2) life; (3) methods of manufacture.
- (*f*) Heat insulation: (1) air chamber *vs.* silica insulation such as "Sil-O-Cel."
- (*g*) Opacity, how obtained in a glaze or enamel.

(11) The following are three of the twelve tests given the class:
- (*a*) Define (*a*) element, (*b*) compound.
- (*b*) Define (*a*) atom, (*b*) molecule.
- (*c*) Give the symbols for: (1) aluminium, (2) iron, (3) oxygen, (4) barium, (5) silicon, (6) sodium, (7) potassium, (8) chlorine, (9) tin, (10) copper.
- (*d*) Balance: (1) $Fe+O \rightarrow Fe_3O_3$; (2) $KClO_3 \rightarrow KCl+O$.
- (*e*) Draw and letter the body triangle. (Class average on this test 86%; four pupils made 100%, and one pupil made below 70%).

Another Test (more advanced:
- (*a*) Balance: (1) $Na_2CO_3+HCl \rightarrow NaCl+H_2O+CO_2$; (2) $Al_2O_3 \cdot 2H_2O+Heat \rightarrow Al_2O_3+H_2O$.
- (*b*) Name the three main kinds of rock and tell how each is formed.
- (*c*) For eight pounds of alumina how much diaspore must be calcined?
- (*d*) What results are caused by an increase in flint?
- (*e*) What is the maximum ball clay content of a white firing body?

(Class average 82%, one pupil made 100%, none made below 70%)

Another Test:
- (*a*) Define refractory.
- (*b*) How long should plaster casts be matured before drying for maximum strength?
- (*c*) What is the safe maximum drying temperature for plaster of Paris?
- (*d*) What is the difference between water of plasticity and pore water?
- (*e*) At what temperature °F will cone 9 come down?
- (*f*) How would you counteract the tendency of white ware bodies to "burn yellow"?
- (*g*) What is: (1) Al_2O_3, (2) $Al_2O_3 \cdot 3H_2O$, (3) $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$, (4) $K_2O \cdot Al_2O_3 \cdot 6SiO_2$, (5) $CaO \cdot Al_2O_3 \cdot 2SiO_2$.
- (*h*) Show (by formula) the change of china clay to mullite.
- (*i*) (1) Why do saggers fail more quickly when burned to cone 14? (2) Give two other reasons for sagger failure.
- (*j*) Develop:

K_2O	.25				
Na_2O	.25	Al_2O_3	.5	SiO_2	1.0
CaO	.50				

(Class average 87%, one made 100% and two fell below 70%)

(12) Class average grade in theory to date, including all test and recitations is 82.76%.

Equipment

The only available room having a drain, was about 24 ft. wide by 32 ft. long. The only equipment, two rough tables, $500 promised by the Board of Education, and materials promised by the potteries. These and more were furnished. All work of installation with the exception of a very few highly specialized jobs, was done by the boys.

At this time we have the following tools, machines and general equipment (usable supplies are not included):

(1) An assortment of small tools too numerous to itemize such as saws, hammers, planes, fettling knives, frogs, etc.
(2) A tool room for the above.
(3) 1 compartment of 6 storage bins.
(4) 5 storage bins of tile (up ended 2 foot sewer tile).
(5) 1 drier.
(6) 150 sq. ft. of shelves.
(7) 1 wet storage cellar, 3 x 3 x 5 feet, plaster lined.
(8) 1 motor-driven jigger (made from an old batting out machine).
(9) 1 motor-driven throwing wheel (made from an old hand-turned jigger).

(10) 1 motor-driven pebble mill (1 gallon, made by boys).
(11) 1 table mounted mold makers whirler.
(12) 1 portable liners whirler.
(13) 2 hand wedging tables (one double-sided unit).
(14) 1 press for dry pressing.
(15) 2 complete die assemblies for above.
(16) 1 complete transverse strength testing machine (lever type).
(17) 1 air brush outfit.
(18) Assortment of mixing bowls, dishpans, pitchers, etc.
(19) Miscellaneous assortment of blocks, cases, and molds.
(20) 1 blunger (in process of construction).
(21) Small items such as lawns, grinding pebbles, sponges, etc. too numerous to list.

At present work is being done on a 16- x 18-foot tile kiln shed which will, when completed, house a small downdraft kiln of 4-sagger capacity, a continuous frit furnace (crucible type), and a small muffle.

Trade Processes

(1) Body mixing (each boy completed each operation at least once).
  (*a*) Blunger screen (necessarily dried on bats).
  (*b*) Pebble mill.
  (*c*) Blunger screen dry pulverize press.
  (*d*) Dry mix.
(2) Plaster.
  (*a*) Mixing, proportions and time (fee).
  (*b*) Making small bat and trimming it.
  (*c*) Making mold (block and case furnished).
  (*d*) Blocking and casing (by demonstration only).
(3) Casting (proved to be distressingly popular).
(4) Jiggering.
(5) Dry pressing.
(6) Throwing.
(7) Hand modeling (clay and plaster).
(8) Bisque and glost.
  (*a*) As all firing was done in the potteries this year not much could be accomplished except seeing that every boy took some ware over and saw how it was placed.
(9) Glaze.
  (*a*) Dipping.
  (*b*) Pouring at least 2 pieces by each boy, by each method.
  (*c*) Spraying.

Experimental: (two boys working together)

(1) Five body mixes.
  (*a*) High feldspar, low flint.
  (*b*) High flint, low feldspar.
  (*c*) Balance.
  (*d*) High ball } on an otherwise normal body.
  (*e*) Low ball }
(2) Shrinkage on these five bodies.
(3) Porosity " " " "
(4) Transverse strength.
(5) Overstaining.
(6) Deflocculation (quantities.)

(Note: At present all energies are focused on kiln construction—these tests to be resumed when the kiln is completed.)

Course in Porcelain Enameling

Those who are interested in porcelain enameling will have an opportunity of taking a complete course on this subject, which is to be given during the period of July 9 through July 23, Cleveland, Ohio, by The Ferro Enameling Company of that city. The course will be under the direction of J. E. Hansen, who is favorably known among the technical

experts of the porcelain enameling industry, and will be studied, from both the technical and practical standpoint.

Some of the subjects that will come up for discussion will be, "Dry Process vs. Wet Process Enameling," "Sand Blasting," "Enamel Shop Management," "Diagnosing Enamel Shop Troubles," etc.

Booklet and complete information may be obtained by writing the Ferro Enameling Company, Cleveland.

INDIAN CERAMIC SOCIETY

C. W. Parmelee, Department of Ceramic Engineering, University of Illinois, has received a letter from T. W. Talwalkar, Poona City, India, a former student in the department, who took his Bachelor's and Master's degree in Ceramic Engineering. He returned to his country arriving there on November 24, 1927, and since his arrival he has been busily organizing an Indian Ceramic Society, of which he is the acting secretary. An organization meeting was scheduled for the early part of this month, and fifty members were enrolled. He has established a laboratory for testing of clays and has also gone into the business of enameling metals. Further, he is a representative of one of the large American companies engaged in the manufacture of machinery for the clay-working industries.

He writes that there are several graduates of American universities in his part of India. Among these is Mr. Nayar who was also a student at the University of Illinois and who is now organizing a Department of Ceramic Engineering at the Hindu University at Benares. Mr. Talwalkar writes that the graduates of American universities are engaged in many activities of a constructive nature.

CLAY PRODUCTS INSTITUTE OF CALIFORNIA

The organization of the Clay Products Institute of California has recently been effected, with headquarters at 611 Architects Building, Los Angeles, Calif. The Institute represents practically all lines of clay products used in building construction and engineering. It was formed for the purpose of supplying technical data as a result of engineering tests regarding the use of clay products and for contact in such matters as building codes, insurance schedules, etc.

The officers for this new organization are:

President: Robert Linton, Vice president and General Manager, Pacific Clay Products Co., Los Angeles.
Vice President: George D. Clark, N. Clark and Sons, San Francisco.
Treasurer: H. B. Potter, Gladding McBean & Co., Los Angeles.
Secretary-Manager: Seward C. Simons,[1] Los Angeles.

Board of Directors:

W. W. Dennis, McNear Brick Co., San Francisco; E. M. Davids, Gladding, McBean & Co., San Francisco; N. A. Dickey, W. S. Dickey Clay Mfg. Co., San Francisco; Gus Larson, Los Angeles Brick Co; Walter Simons, Simons Brick Co., Los Angeles; G. A. Wild, Western Brick Co., Los Angeles.

OFFICERS OF THE AMERICAN REFRACTORIES INSTITUTE

Officers and Directors of the American Refractories Institute, as elected at the Annual Meeting, May 8, held at White Sulphur Springs, Va., are as follows:

[1] Formerly Manager, Domestic Trade Department and Secretary, Construction Industries Committee, Los Angeles Chamber of Commerce.

President, J. M. McKinley, Vice Pres. & Genl. Mgr., Crescent Refractories Co., Curwensville, Pa.

1st Vice President, R. M. Sievers, Vice Pres. & Gen. Sales Mgr., Evens & Howard Fire Brick Co., St. Louis, Mo.

2nd Vice President, W. B. Coullie, Asst. Genl. Sales Mgr., Harbison-Walker Refractories Co., Pittsburgh, Pa.

Treasurer, C. C. Edmunds, Treasurer, McLain Fire Brick Co., Pittsburgh, Pa.

Secretary, Dorothy A. Texter, Pittsburgh, Pa.

DIRECTORS

3-year term (1928–1931)

G. A. Balz, Pres. & Genl. Mgr., Seaboard Refractories Co., Perth Amboy, N. J.
J. D. Ramsay, Pres., Elk Fire Brick Co., St. Marys, Pa.
J. E. Lewis, Pres. Harbison-Walker Refractories Co., Pittsburgh, Pa.
Burrows Sloan, Pres., General Refractories Co., Philadelphia, Pa.
A. P. Taylor, Pres., The Chas. Taylor Sons Co., Cincinnati, O.
A. P. Green, Pres., A. P. Green Fire Brick Co., Mexico, Mo.
H. L. Tredennick, Pres., Haws Refractories Co., Johnstown, Pa.
T. N. Kurtz, Pres., U. S. Refractories Corp., Pittsburgh, Pa.

CONFERENCE OF EDITORS OF SOCIETY-OWNED PUBLICATIONS

A conference of editors of society-owned publications was held in rooms of the American Society of Mechanical Engineers, New York City, on June 1.

Those who attended the meeting were H. E. Howe, *Industrial and Engineering Chemistry;* E. J. Crane, *Chemical Abstracts;* Neil E. Gordon, *Journal of Chemical Education;* L. A. Olney, *American Dyestuff Reporter;* Sidney E. Wilmot and H. T. Larsen, American Society of Civil Engineers; George Metcalf, American Institute of Electrical Engineers; D. L. Fisk, American Society of Refrigerating Engineers; W. Spraragen, American Welding Society; T. T. Read, American Institute of Mining and Metallurgical Engineers; C. E. Haywood, and C. F. Clarkson, Society of Automotive Engineers; C. E. Davies, L. Cammen, G. A. Stetson, and R. R. Leonard, American Society of Mechanical Engineers, and Miss Emily C. Van Schoick, AMERICAN CERAMIC SOCIETY.

H. E. Howe was in charge of the discussion and each member present answered the questionnaire mailed out before the conference regarding data about each publication.

The next meeting will be held on October 5 and the following topics will be discussed informally:

(1) Why do societies publish? Discussion opened by C. E. Haywood.

(2) The relation of the society-owned publication to the trade press. Discussion opened by L. A. Olney.

(3) Indices. Discussion opened by E. J. Crane.

(4) Style Manual. Discussion opened by G. A. Stetson.

President of Fostoria Glass Company

Announcement is made of the choice of Clavin B. Roe to succeed the late W. A. B. Dalzell as president of the Fostoria Glass Co. He had been a close companion of Mr. Dalzell for 33 years and vice-president of the firm since 1902. He is also president of the National Assn. of Manufacturers of Pressed and Blown Glassware.

SECOND NATIONAL FUELS MEETING; A.S.M.E.

The Second National Fuels Meeting will be held in Cleveland, Ohio, Sept. 17–20, 1928. The reports of the committees in charge of the program indicate that this will be a most valuable and interesting session. Papers are being prepared by some of the outstanding engineers and scientists in the fuel and power fields. The Fuels Divsion of the American Society of Mechanical Engineers is devoting considerable time and thought to the preparation of a well-rounded and broad selection of subjects and speakers. In addition to the technical program, arrangements are being made for a number of interesting inspection trips to the leading plants in the vicinity.

Attendance to, and participation in these National Fuels Meetings is by no means limited to the membership of the A.S.M.E. The meetings are exactly what their title implies: National Fuels Meetings. They are for any one interested in the production, distribution, or utilization of fuels.

The papers for the Cleveland meeting will cover the use of solid, liquid, and gaseous fuels in all fields.

Years ago the central station engineers recognized the vital importance of their fuel problems, studied them individually and collectively, and interchanged their ideas and experiences among themselves. The steel men were confronted with similar problems and they also interchanged ideas with other steel men. The refractory, terra cotta and other clay products engineers began to study their problems and interchange notes with others in their industry. This awakening and realization of the fact that each has his fuel problems spread to practically all industries. Some of these industries have made great progress with their fuel problems, some are just beginning to make a showing, and some are still struggling to master the elements of their problems.

Thus the movement toward the mastery of fuel problems has been under way in many industries and organizations, but one vital element has been missing—*coöperation, the interchange of ideas, problems and solutions among the different industries and the different organizations.* Here were many individuals or organizations all attacking the same problem, but each starting at the very bottom and passing through the same stages of mistakes and progress and attempting to reach the same final success. Each individual had special problems of his own. Some of the details of the problems were special, but the same fundamental underlying principles applied to all alike, and even many of the so called "specialized details" were not so specialized after all and could be adapted to the problems of some other individual.

TESTS FOR COMMON BRICK[1]

The only comprehensive standard tests of common brick in Utah were those made by the Mechanical Engineering Department of the University of Utah.

Lots of 50 brick each, representative of several kinds and grades, from each of the several manufacturers, numbering 950 in all, were procured. From each of these lots, 10 brick were selected at random and these 190 samples were tested for transverse, shear and compressive strength and for absorption.

On the whole the tests show high values for strength, some individual brick having strengths of over 10,000 and 11,000 lbs. per square inch. Average values for strength and absorption are presented in the following summary:

---

[1] *The Pyrogram*, Official Organ, Western Clay Products Assn., Salt Lake City, Utah.

Plant	Kind of Brick	Strength in lbs. per sq. in. Transverse	Shear	Compression	Absorption
A	Straw, wire-cut	956	1090	7210	18.60%
	Mott. red, pressed	992	757	4310	21.77
	Straw, "	599	527	3170	21.11
B	Straw, wire-cut	800	415	2031	29.90
	Straw, pressed	423	481	1594	30.57
C	Pink, wire-cut	675	363	3145	20.63
	Straw, pressed	417	384	2113	22.30
	Light, "	264	221	2232	7.12
D	Pink, sand-roll	744	418	2950	22.50
	Red, "	436	242	1200	—
E	Straw, pressed	475	474	2268	27.65
	Buff, wire-cut	1184	897	7327	8.26
	Dark buff, "	926	716	4243	16.63
F	Pink, pressed	169	307	1832	16.10
	Pink buff, "	356	369	2185	29.59
	Buff, wire-cut	511	491	2765	23.60
	Hollow, "	595	457	1287	20.80
G	Buff, "	564	514	2860	22.77
	Red, pressed	310	287	1851	27.25
Av.		600	500	3000	20.37

It will be noted that the values for the wire-cut brick run consistently higher than those for pressed brick, the average for the former being 4225 lbs. per sq. in. as against 2400 lbs. per sq. in. for the latter. Neither of the brick showing strengths of 1200 and 1287 in compression are now being made and all brick tabulated and now made are much stronger than required by codes.

SIMPLIFICATION PROJECT FOR STAPLE VITREOUS CHINA PLUMBING FIXTURES

A sufficient number of written acceptances having been received for Simplified Practice Recommendation No. 52, Staple Vitreous China Plumbing Fixtures, recently reaffirmed by the Advisory Committee without change, the Division of Simplified Practice, of the Department of Commerce, has announced that the project is now in effect, subject to annual revision or reaffirmation by the industry.

Eighty per cent of the known manufacturers, distributors, and organized users, by volume of output, must accept the recommendation in writing before it can be placed in effect by the Department of Commerce. Information, presented to the Advisory or Standing Committee for the simplification, indicated a very satisfactory degree of adherence to the recommendation.

THE AMERICAN ENAMELER

The Porcelain Enamel & Mfg. Company of Baltimore, Md., is issuing a new publication, *The American Enameler*. The journal runs from 16 to 20 pages an issue, is printed on enamel finish paper, and is most attractive in type style, photography, and cover makeup. The purpose of the magazine as stated is "to disseminate ideas, information, and news which will be of interest to all who are interested in the progress and development of the porcelain enamel industry."

NEW CANADIAN JOURNAL

Clay Products News and Ceramic Record edited by Gordon C. Keith is being issued by the Canadian National Clay Products Association. The first issue was distributed in April.

News from the various branches of the ceramic industry in Canada is featured.

OHIO CERAMICS INDUSTRIES ASSOCIATION

The spring meeting of the Ohio Ceramic Industries Association was held on May 11 at the Roseville, Ohio, Engineering Experimental Plant, Ohio State University. Approximately fifty manufacturers inspected this plant.

G. A. Bole, Secretary of the Association was in charge of the session in the absence of J. L. Murphy, president.

(1) Wilbur Stout, assistant geologist, Ohio Geological Survey, explained the geology of the clay and shale deposits on the property. He stated that at no other place in the country are there so many commercial clay seams in ledge exposure. The Tionesta, Brookville, Lower Kittanning, Oak Hill, and Middle Kittanning, with their accompanying shales are all above plant level. The pit is over 100 feet high in three benches. Immediately below plant level is the Bedford clay and about twenty feet below this are the Mercer and Flint ridges. The commercial use for each of the clays was explained.

(2) A. S. Watts pointed out the necessity of having the Ohio manufacturers behind the work of the Ceramic Department at Ohio State University.

(3) G. A. Bole spoke on the advantages accruing from such an experimental station as the one at Roseville. He listed the different types of the employees at the Roseville plant: (*a*) research engineers, full-time employees of the university who carry on research on general problems and direct work of research fellows; (*b*) research fellows, graduate students, working for higher degree, paid by one industry, solving simpler problems peculiar to that industry; (*c*) research engineers, full-time men paid by one manufacturer, a group of manufacturers, or an association, working on problems peculiar to the manufacture of their product; (*d*) contact engineers: paid by the industry to go into plants, study the problems, and if unable to solve them at the plants, to bring them to Roseville for solution; they also put the results of research done at Roseville to work in individual plants of the industry.

The contact engineer was stressed as being the crux of the situation; to put research to work is the main purpose of the experimental unit, the connecting link between fundamental research and plant practice.

The equipment of the plant was also discussed at length.

Other papers presented were:

(4) H. E. Nold,[1] "Clay Mining and Manufacture in Ohio, a Technical Survey."[2]

(5) J. E. Clark,[3] "The Coöperation of the Welfare Department and the Experimental Plant."

(6) R. B. Keplinger,[4] "The Needs of the Industry."

(7) T. A. Klinefelter,[5] "General Research Problems."

C. S. Finzer, Finzer Bros. Clay Co., and J. O. Wilcox, Alliance Clay Products Co., talked briefly.

White Wares Division Meeting

The members of the White Wares Division of the Ohio Ceramic Industries Association met in East Liverpool on May 24. During the morning seventy members visited the plants of the Hall China Company and Homer Laughlin China Company. The business session was held in the rooms of the U. S. Potters' Association. The following papers were presented:

[1] Professor, Department of Mine Engineering, Ohio State Univ.

[2] Ohio State Univ., Eng. Expt. Sta., *Circ.*, No. 14.

[3] Manager, Mfg. Sales Dept., Welfare Dept., State of Ohio.

[4] Metropolitan Paving Brick Company, Canton, Ohio.

[5] U. S. Bureau of Standards, Columbus Station, Chairman, Research Comm.

"Survey of the White Ware Industry of Ohio," by A. S. Watts.
"The Tariff Situation in the Whiteware Industry," by F. H. Rhead.
"Research and Education Program of the Ohio Ceramic Industries Association," by W. Keith McAfee.

At the evening session papers were presented as follows:

"Mechanical Development," by A. A. Wells.
"Importance of Art in the Industry," by J. C. Boudreau.
"Some Physical Facts in Relation to Ceramic Production," by A. V. Bleininger.

The next meeting of this Division of the Association will be held at the time of the annual meeting in the autumn of this year.

CALENDAR OF CONVENTIONS

American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1929	New York City
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	February	Chicago, Ill.
(Pacific Northwest Section)	Aug. 31–Sept. 1	Yakima, Wash.
American Chemical Society	Sept. 10–15	Swampscott, Mass.
American Concrete Institute		
(Annual Meeting)	Feb. 12–14, 1929	Detroit, Mich.
American Electrochemical Soc.		
(Fall Meeting)	Sept. 20–22	Charleston-Hungtington, W. Va.
American Institute of Chemical Engrs.		
Industrial Tour of Canada and U. S.	Aug. 18–Sept. 2	
Amer. Inst. Min. and Met. Engrs.		
(Regional)	Aug. 29–31	Boston, Mass.
American Gas Assn.		
(Annual Meeting)	Oct. 8–12	Atlantic City, N. J.
American Soc. of Mechanical Engrs.		
(Summer Meeting)	Aug. 27–30	St. Paul-Minneapolis
(Regional)	Oct. 1–3	Boston, Mass.
(Annual Meeting)	Dec. 3–7	New York City
(Second Natl. Fuels Meeting)	Sept. 17–20	Cleveland, Ohio
American Soc. for Steel Treating		
(Annual Meeting)	Oct. 8–12	Philadelphia, Pa.
(Semi-Annual)	Jan. 14–18, 1929	Los Angeles, Cal.
American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Assn. of Scientific Apparatus Makers of America	May 3, 1929	Atlantic City, N. J.
National Assn. of Manufacturers	Oct. 22–25	New York City
Natl. Assn. of Mfgrs. of Heating and Cooking Appliances	May 8–9, 1929	New York City
Natl. Assn. of Mfgrs. of Pressed and Blown Glassware	July 16	Atlantic City, N. J.
Natl. Exposition of Power & Mechanical Engrs.	December 3–8	New York City
Natl. Glass Distributors Assn.	Dec. 4–5	Pittsburgh, Pa.
Optical Society of America	Nov. 1–3	Washington, D. C.
Safety Congress	Oct. 1–5	New York City
Taylor Society	Dec. 5–8	New York City

WE invite your inspection of the Journal advertising section for the purpose of determining its fitness for your needs, either to advertise your wares or to secure the knowledge of what and where to buy the best materials and equipment obtainable for use in the ceramic industry.

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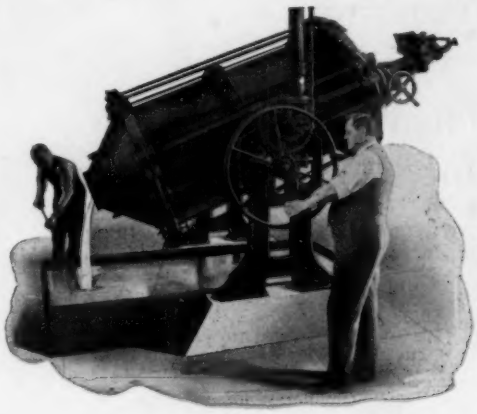

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C

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Drying Machinery
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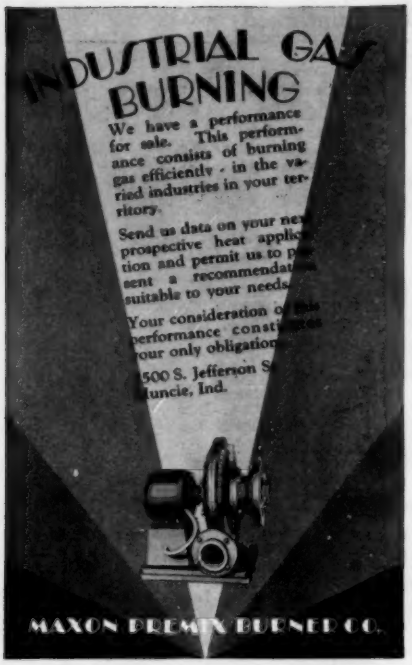
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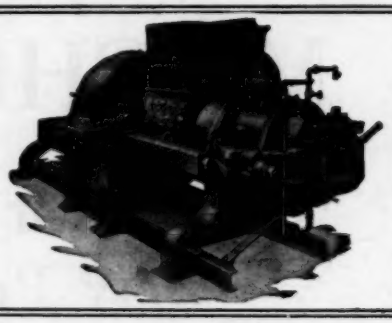

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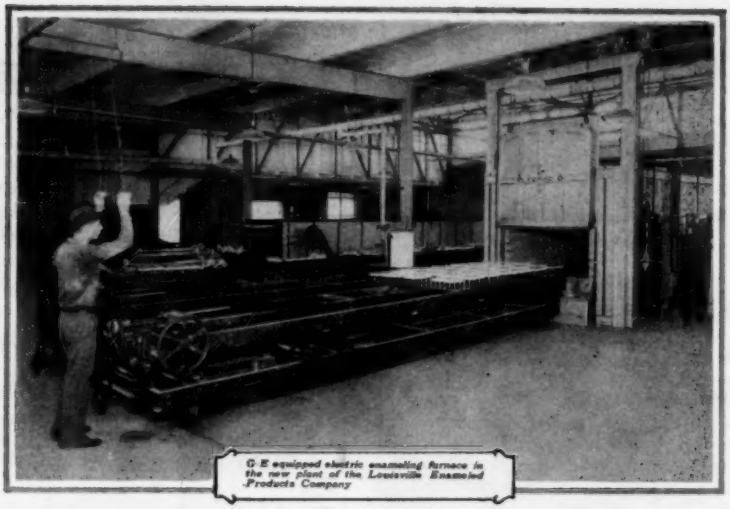

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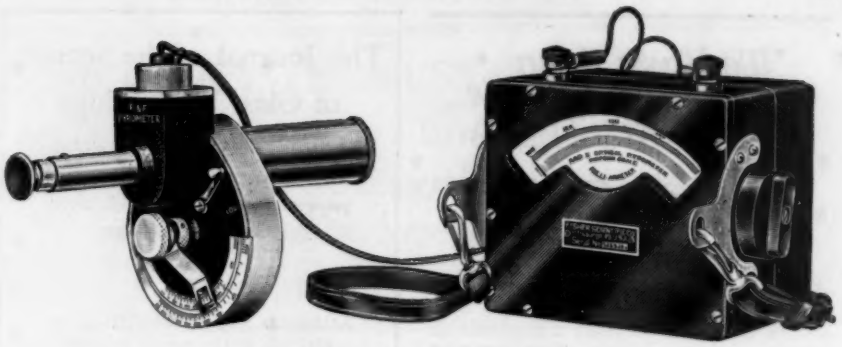

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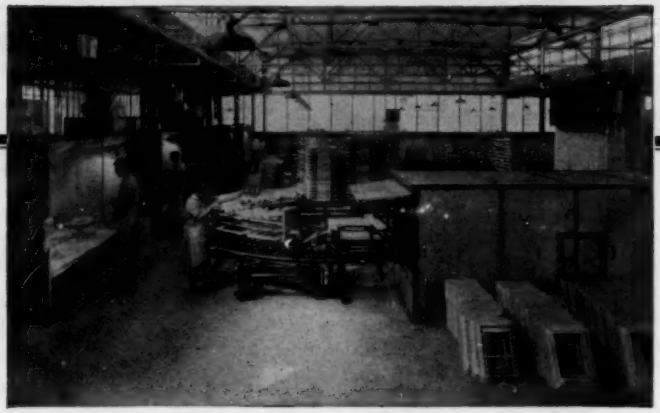

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